ASSESSMENT OF
WIND ENERGY POTENTIAL

St. Anthony, Nfld.

ASSESSMENT OF WIND ENERGY POTENTIAL

ST. ANTHONY, NFLD.

Prepared for:

Town of St. Anthony

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St. John's, Nfld

With a contribution from:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada

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EXECUTIVE SUMMARY

The Town of St. Anthony contracted Fenco Newfoundland Limited to carry out a preliminary analysis of the wind energy potential within a 40km radius of the Town. The study was made possible by a financial contribution to the town from the Remote Community Demonstration Program (RCDP) of Energy, Mines and Resources Canada.

The study's objective was to select three sites, from an initial selection, that show the highest potential for wind energy conversion. The "Assessment Methodology for a Preliminary Selection of Wind Energy Conversion System Sites in Remote Communities",* provided by Energy, Mines and Resources Canada, formed the basis of the site selection procedure. Points were awarded for each of the fifteen (15) items in the Decision Matrix, as outlined in the methodology, and totalled to determine the best locations.

The initial task of the study was to carry out a preliminary assessment of the region. This involved gathering all available background information and mapping for the St. Anthony area. An initial selection of sites was made by considering windfield obstructions, site access, transmission line connection distance, and existing structures. Aerial photographs were obtained for each of these sites. All items of the Decision Matrix that did not require a field investigation were evaluated.

Once the preliminary assessment was completed, a field trip and site investigation was undertaken. This involved visiting each of the initial sites to obtain all necessary field information. The location of roads and transmission lines were confirmed while enroute to the sites. Photographs were taken for each location to assist in site

* (See page viii)

descriptions. Snow cover during the visit made some visual observations difficult. With this field information, the remainder of the Decision Matrix could be evaluated.

Once all items in the matrix had been evaluated, point scores for each site were totalled. The four communities that showed the highest potential are as follows:

Site 10	Cape Norman	155 pts
Site 9	Cook's Harbour	150 pts
Site 3a	Cremaillere Hill, St. Anthony	145 pts
Site 7	L'anse aux Meadows	130 pts

The final site selection involved final comments on the top four sites and any other information that may have been relevant to the final site selection for the purpose of wind monitoring. L'anse aux Meadows, the fourth choice, was eliminated from the selection due to its lengthy connection distance to three phase transmission lines, and its close proximity to a National Historic Site. Cape Norman is closer to transmission lines than Cook's Harbour, but it is not closer to three phase power, which may prove to be an asset. Finally, if the hills to the northwest of St. Anthony do not obstruct the winds to Cremaillere Hill, then this site will have to be re-evaluated.

The major conclusions and recommendations are summarized below:

1. The Assessment Methodology has been primarily developed for a remote community site assessment, not for an area of interconnected communities.

2. More consideration should be given to sites showing high average wind speed, where data is available.

3. Equipment and Skills Availability, and Social Impacts are not as important in site selection as the other items, thus point weightings seem high.

4. Access, as specified in the Assessment Methodology, only applies to remote communities. It was rewritten in this study.

5. If acquisition is economically unfeasible, a site should be eliminated rather than awarded 0 points.

6. The connection distance item should consider whether transmission lines are single phase or three phase.

7. The possibility of a wind farm should be investigated at each site.

8. Surface roughness and environmental impacts should be included in the assessment methodology.

9. The usefulness of the Community Questionnaire is uncertain at best. It was eliminated from this study.

Note: This report covers the first part of a study to assess wind potential in the St. Anthony area. Monitoring of wind speed, direction, etc. at the most promising site (determined by this part 1 study) is to take place for 12 months after April 1, 1985.

* Developed as part of a prefeasibility study entitled "Wind Energy Conversion System, South Coast Region of Newfoundland" by ShawMont Newfoundland Ltd. for Newfoundland and Labrador Hydro. The study was financed with a contribution from the Remote Community Demonstration Program of Energy, Mines and Resources Canada.

ÉVALUATION DU POTENTIEL EN ÉNERGIE ÉOLIENNE

ST. ANTHONY (TERRE-NEUVE)

Résumé

La ville de St. Anthony a retenu les services de la Fenco Newfoundland Limited pour effectuer une analyse préliminaire du potentiel en énergie éolienne dans un rayon de 40 km de la ville. L'étude a été rendu possible par une contribution financière faite à la ville en vertu du Programme de démonstration dans les collectivités éloignées (PDCE) d'Énergie, Mines et Ressources Canada.

L'objectif de l'étude consistait à choisir parmi une sélection initiale trois sites qui offrent le potentiel le plus élevé de conversion de l'énergie éolienne. La "méthodologie d'évaluation d'un choix préliminaire de sites d'installation de systèmes de conversion de l'énergie éolienne dans les collectivités éloignées"* fournie par Énergie, Mines et Ressources Canada, a constitué la base du processus de sélection des sites. Des points ont été accordés pour chacun des 15 facteurs dans la matrice de décision, comme le définissait la méthodologie, et totalisés, ce qui a permis de déterminer les meilleurs endroits.

La tâche initiale de l'étude a consisté à effectuer une évaluation préliminaire de la région. Il s'agissait de recueillir tous les renseignements de base disponibles et toutes les cartes de la région de St. Anthony. Un premier choix de sites a été fait compte tenu des obstructions du champ du vent, de l'accès aux sites, de la distance de raccordement aux lignes de transport d'énergie et des structures existantes. Des photographies aériennes ont été obtenues pour chacun de ces sites. Tous les facteurs de la matrice de décision qui ne nécessitaient pas de recherches sur le terrain ont été évalués.

Une fois l'évaluation préliminaire achevée, des excursions sur le terrain et des études de site ont été entreprises. Il a fallu visiter chacun des sites initiaux pour obtenir tous les renseignements nécessaires. L'emplacement des routes et des lignes de transport d'énergie a été confirmé pendant le trajet jusqu'à ces sites. Des photographies ont été prises pour chaque emplacement afin d'aider à la description des sites.

La couverture de neige présente durant la visite a rendu difficile certaines observations visuelles. Avec ces renseignements, on a pu évaluer le reste de la matrice de décision.

Note: Ce rapport porte sur la première partie d'une étude visant à évaluer le potentiel en énergie éolienne dans la région de St. Anthony. Les relevés de la vitesse, de la direction du vent, etc., seront effectués au site offrant le plus de potentiel (voir première partie de l'étude) dans 12 mois après avril 1985.

* Méthodologie élaborée dans le cadre de l'étude préliminaire de faisabilité intitulée "Système de conversion d'énergie éolienne, côte sud de Terre-Neuve", par la ShawMont Newfoundland Ltd. pour la Newfoundland and Labrador Hydro, grâce à une subvention du Programme de démonstration dans les collectivités éloignées d'Énergie, Mines et Ressources Canada.

Une fois que tous les facteurs de la matrice ont été évalués, le total des points a été fait pour chaque site. Les quatre collectivités qui ont accusé le potentiel le plus élevé sont les suivantes:

Site 10	Cape Norman	155 points
Site 9	Cook's Harbour	150 points
Site 3a	Colline Crémaillère, St. Anthony	145 points
Site 7	L'Anse aux Meadows	130 points

La sélection finale des sites comprenait des observations finales sur les quatre sites placés en tête de liste et tous autres renseignements qui pouvaient être pertinents à la sélection finale des sites pour la surveillance du vent. L'Anse-au-Meadow, la quatrième possibilité, a été éliminée de la liste en raison de la longue distance de raccordement avec les lignes de transport triphasées, et en raison de la proximité d'un site historique national. Cape Norman est plus proche des lignes de transport que Cook's Harbour, mais n'est pas plus proche du réseau de distribution triphasé, ce qui pourrait être un atout. Enfin, si les collines situées au nord-ouest de St. Anthony ne font pas obstruction aux vents de la Colline Crémaillère, il faudra alors réévaluer ce site.

Voici, en résumé, les principales conclusions et recommandations:

1. La méthode d'évaluation a été surtout élaborée pour une évaluation de site dans une collectivité reculée, et non pas pour une zone de collectivités interconnectées.

2. Il faudrait accorder davantage d'attention aux sites où la vitesse moyenne du vent est élevée, là où des données sont disponibles.

3. La disponibilité de l'équipement et des compétences, ainsi que les répercussions sociales ne sont pas aussi importantes, dans le choix des sites, que les autres facteurs, ce qui explique que le total des moyennes pondérées est aussi élevé.

4. L'accès, comme le précise la méthodologie d'évaluation, ne s'applique qu'aux collectivités reculées. Ce facteur a fait l'objet d'une nouvelle rédaction dans la présente étude.

5. Si l'acquisition d'un site est économiquement infaisable, il faudrait éliminer ce site au lieu de lui accorder 0 point.

6. À propos de la distance de raccordement, il faudrait considérer si les lignes de transport sont monophasées ou triphasées.

7. Il faudrait envisager la possibilité d'installer un parc d'éoliennes sur chaque site.

8. Les accidents de terrain et les répercussions environnementales devraient être inclus dans la méthodologie d'évaluation.

9. L'utilité du questionnaire relatif aux collectivités est douteuse dans le meilleur des cas. Il a été éliminé de la présente étude.

1.0 INTRODUCTION

1.1 Study Background

Fenco Newfoundland Limited was contracted by the Town of St. Anthony to carry out a preliminary analysis of the wind energy potential within a 40 km radius of St. Anthony. The study was carried out under the Remote Community Demonstration Program (RCDP) of the Federal Government.

The study was conducted from February to March, 1985, when the draft final report was submitted.

The study was subdivided into five (5) major tasks:

Task 1: Preliminary Assessment of the Area

Task 2: Field Trip and Site Investigation

Task 3: Priorize the Sites Identified

Task 4: Final Site Assessment

Task 5: Final Report Production

1.2 Program Background

The Remote Community Demonstration Program (RCDP), supporting this study, is a program managed by Energy, Mines and Resources Canada. The objective of this program is to assist remote communities and agencies responsible for their energy supply, to identify more appropriate energy alternatives and energy conservation opportunities. The program is divided into two (2) phases. Phase 1 offers limited financial assistance for carrying out studies to

explore these alternatives and opportunities. Phase 2 will contribute funds to a limited number of demonstration projects in selected remote communities across Canada. The program will then transfer the knowledge gained from funded studies and projects to all communities and agencies where this knowledge is needed.

1.3 Authorization

Fenco Newfoundland Limited, on behalf of the St. Anthony Town Council, submitted a proposal on February 17, 1984, to the Remote Community Demonstration Program. The scope of work, originally proposed, was of greater detail than that of the present study being conducted by Fenco. It contained provision for twelve months of wind monitoring on two sites, data analysis and scheme feasibility report. This study deals with Stage I of the overall scope of work outlined in the revised scope of work and shown in the Terms of Reference in Appendix 1. In February of 1985, final financing arrangements were negotiated with Energy, Mines and Resources Canada. Fenco Newfoundland Limited was then authorized to proceed with the analysis study.

1.4 Terms of Reference

The Terms of Reference for the study were as stated in the Work Statement in Annex A to the Agreement between Canada and the Town of St. Anthony, dated January 11, 1985, (see Appendix 1).

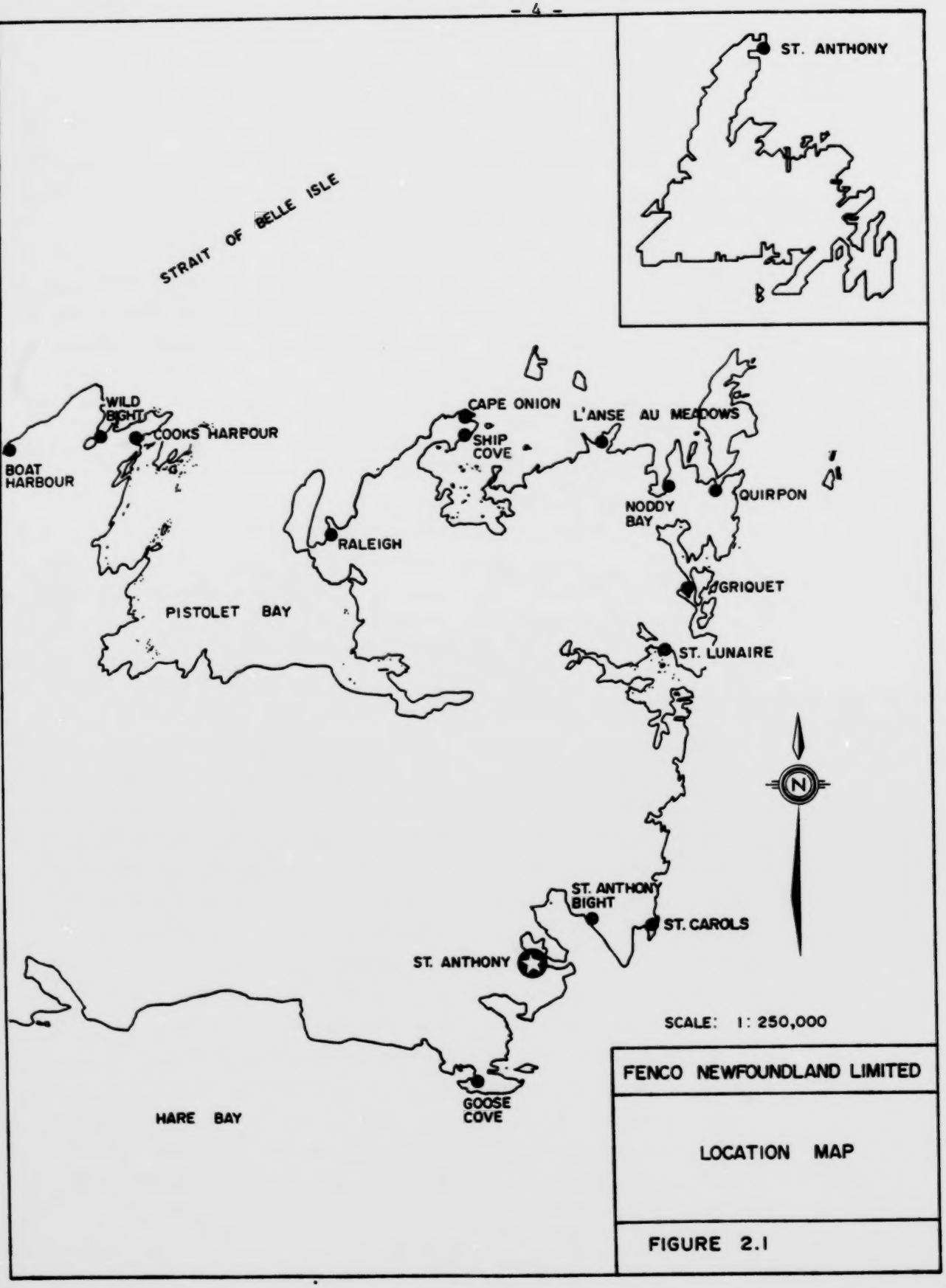
2.0 GENERAL STUDY DESCRIPTION

2.1 Regional Setting

St. Anthony is situated in northern Newfoundland, and is the largest of the communities scattered along the Great Northern Peninsula. In fact, it is the largest of the Newfoundland remote communities relying on diesel generators as its main source of energy (Figure 2.1).

A 6,000 kW (firm) diesel generating plant, located in St. Anthony, provides electrical service to the town, as well as a large number of communities in the region. The communities serviced are Boat Harbour, Cape Onion, Ship Cove, Cook's Harbour, Goose Cove, L'Anse aux Meadows, Noddy Bay, Quirpon, Raleigh, St. Anthony Bight, St. Carrol's, St. Lunaire, Griquet, and Wild Bight.

St. Anthony has a population of 3,107 (1981 Census of Canada), and is considered the service center for the most northerly communities on the island of Newfoundland. Due to high natural growth and in-migration rates, St. Anthony's population is projected to grow to 3,728 people by 1991. The economy is based mainly on three (3) sectors, namely the fishery (38.5% of total employment), institutions (38.5%), and retail/service industries (13%, excluding the new shopping centre). The institutional sector is mainly made up of the regional hospital and the various Provincial Government estabishments. As a potential offshore oil and gas supply base, St. Anthony is in a good position to assemble supplies by water, road, and air. A new airport for the St. Anthony region is nearing completion and new airstrips are planned for many coastal Labrador communities. (Ref. The Municipal Plan of St. Anthony, 1981-1991).



FENCO NEWFOUNDLAND LIMITED

LOCATION MAP

FIGURE 2.1

St. Anthony lies in one of the more wind abundant areas of the Province. Average monthly wind speeds, sampled approximately 3 km west of the Town, ranged from 20.1 to 27.9 km/hr during the years 1970-1980. Average monthly wind speeds, sampled right in the Town ranged from 16.0 to 24.2 km/hr during the years 1955-1980.

As can be seen in Figure 2.2 and Table 2.1, St. Anthony, and more generally Newfoundland, lies in one of the highest wind power regions in Canada. The northeast coast of Newfoundland, the Northern Peninsula, and Labrador all lie in extremely high wind density areas.

2.2 Study Overview

The scope of work intended for this overall study has been divided into two stages:

Stage 1 involved using the "Assessment Methodology for a Preliminary Selection of Wind Energy Conversion System Sites in Remote Communities" to conduct a desk assessment for the area in an attempt to identify all promising wind generator sites. Once this was completed, a field trip to St. Anthony was carried out. Each site identified in the desk assessment was visited to collect all additional information required to complete the final assessment. The sites were then priorized and three sites chosen. The results of this assessment and field visit are contained in this report.

Stage II will involve a twelve month monitoring period, by Newfoundland and Labrador Hydro, at one or more of the selected sites. The Town of St. Anthony will provide for regular data collection and inspection of the monitioring equipment. The Department of Mines and Energy will be responsible for the data analysis and reporting associated with Stage II.

FIGURE 2.2 NATIONAL ANNUAL AVERAGE WIND POWER DENSITY

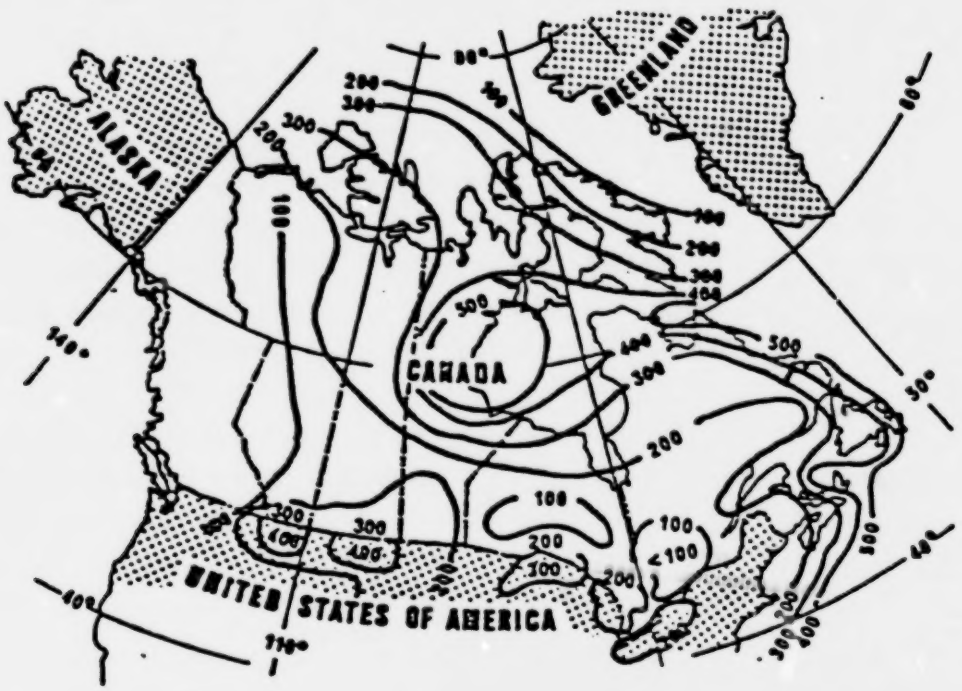


TABLE 2.1 WIND POWER POTENTIAL FOR CANADA, (MW).
AREAS CONSIDERED ARE WITHIN 150 km OF EXISTING NETWORKS

	POWER DENSITY W/m²						
REGION	100-200	200-300	300-400	400-500	>500	>100 @ 30 DIA.	>100 @ 10 DIA.
YUKON	-	-	-	-	-	-	-
N.W.T.	1 600	1 900	-	-	-	3 500	31 500
B.C.	-	-	-	-	-	-	-
ALBERTA	3 700	1 200	300	-	-	5 200	46 800
SASK.	4 700	4 000	1 400	-	-	10 100	90 900
MAN.	1 380	5 600	2 300	830	1 760	11 870	106 830
ONT.	7 500	-	-	-	-	7 500	67 500
QUEBEC	8 500	3 500	-	-	-	12 000	108 000
N.B.	1 000	-	-	-	-	1 000	9 000
N.S.	-	1 000	280	20	-	1 300	11 700
P.E.I.	-	-	200	-	-	200	1 800
NFLD.	1 000	1 400	4 000	1 300	700	8 400	75 600
TOTAL	29 380	18 600	8 480	2 150	2 460	61 070	549 630

PRINCIPAL SOURCE: NATIONAL RESEARCH COUNCIL, CANADA, 1977
NOTE: DENSITY IS MEASURED IN W/m² AT 30 m HEIGHT
POTENTIAL BASED ON 30 & 10 DIAMETER SPACING BETWEEN WTGs

3.0 DESK ASSESSMENT

3.1 Site Assessment Methodology

The "Assessment Methodology for a Preliminary Selection of Wind Energy Conversion System Sites in Remote Communities" provided by Energy, Mines and Resources Canada, was the basis used to carry out the study. In this Assessment Methodology, a Decision Matrix was developed to assist in making an initial investigation and deciding as to the wind potential of a region and a particular site(s) within that region. The methodology was designed on the basis of an evaluation matrix which permits the assigning of numerical values to relevant characteristics of potential wind energy conversion systems (WECS) sites such that the sites may be compared and the best site or sites chosen. The weighing values given to each category are based on that category's importance in regard to the applicability of a site to support a WECS. Points are awarded, to the categories in the matrix, according to the guidelines outlined and sites with the greatest point total are selected.

Many of these categories are assigned weights in the Desk Assessment. Weights for the remaining categories are determined by a field visit to each of the initial proposed sites.

The Assessment Methodology does not consider the possiblility of establishing a wind farm, that is, more than one wind turbine per site. Since the minimum load on this grid is 1500 kW, the connection of more than one WECS into the grid will not cause problems. Hence, the size of each site was considered as part of the evaluation, in the event that a wind farm proves to be the most economical alternative.

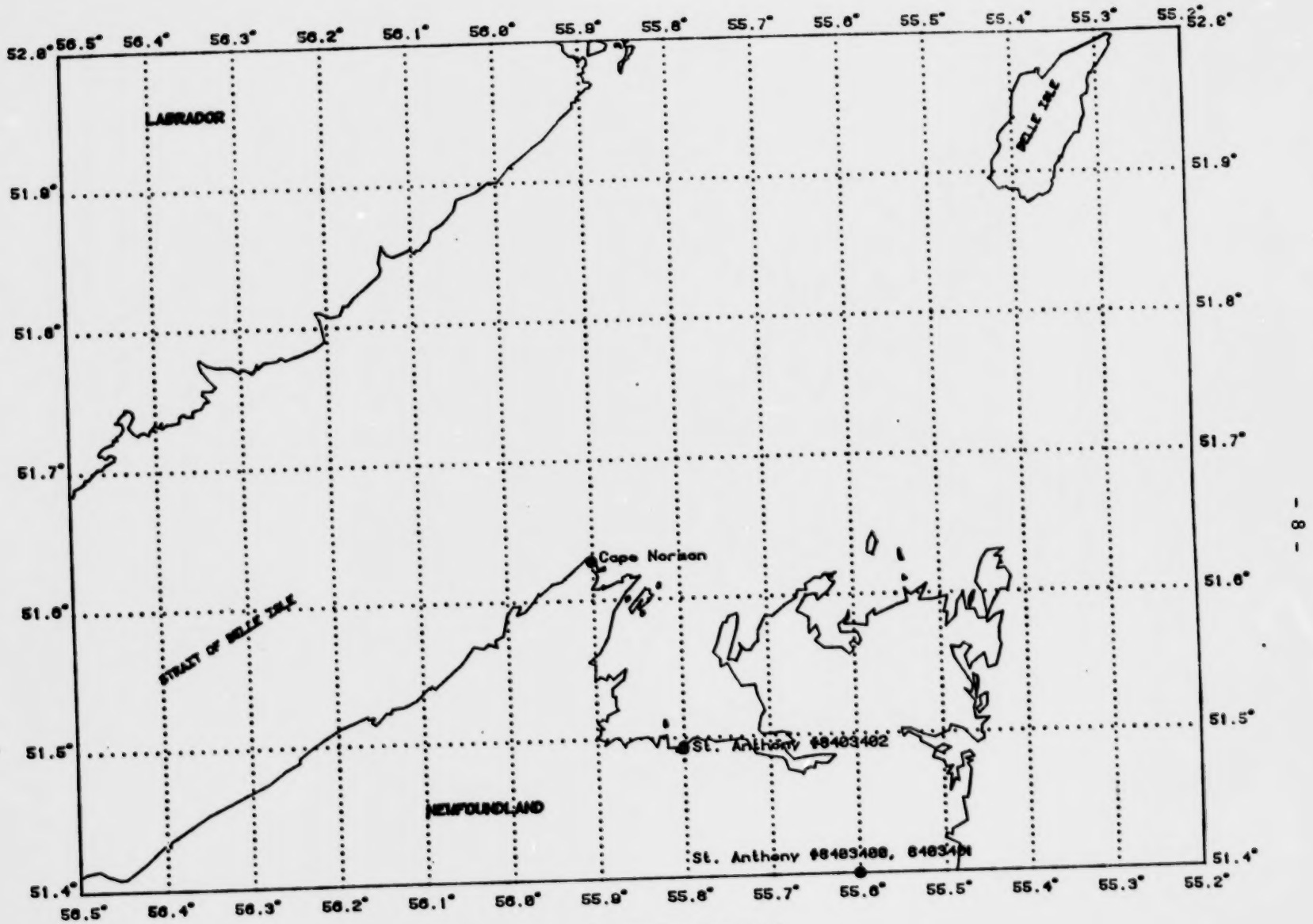


Figure 3.1 CHART DEPICTING CAPE NORMAN AND ST. ANTHONY STATIONS.

An outline of the fifteen (15) categories of the Decision Matrix and how they were considered for this study is discussed as follows:

3.1.1 Windfield

Historical wind data for the St. Anthony area were obtained as part of this study. Longterm wind observation analyses for three St. Anthony stations from 1953-65, 1970-84, and 1966-84, respectively, were obtained through the Atmospheric Environment Service (AES) LAST (LAnd STatistics) database.

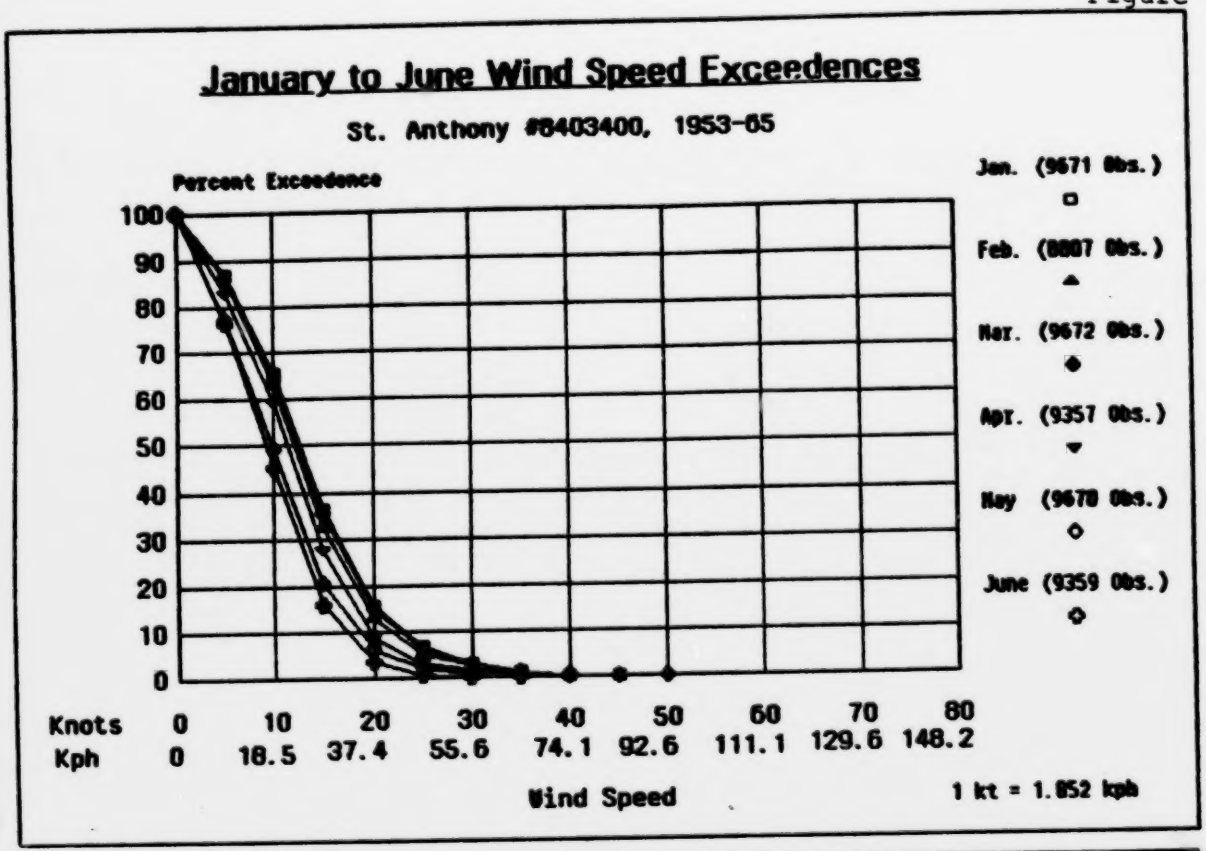
Wind records collected by the Canadian Coast Guard (CCG) from May 17 to July 31, 1982, at Cape Norman, Newfoundland, were extracted from the CCG report, No. TP 3870E, "Marine Traffic Analysis Project, Cape Norman, Strait of Belle Isle Appendix A: Recorded Data, May 17 - July 31, 1982".

Figure 3.1 depicts the northern area of the Strait of Belle Isle. Cape Norman and the position of the St. Anthony stations providing the longterm wind observations are labelled on this chart.

A number of graphs were prepared to illustrate and compare wind conditions for the various locations. It should be kept in mind that the information for Cape Norman consists of only 560 synoptic observations made during the late spring and summer when wind conditions are more moderate than at other times of the year.

As Figures 3.2 to 3.4 and Table 3.1 show, higher wind speeds occur with greater frequency in St. Anthony from October to March. Also, winds tend to blow most frequently from the West and Southwest in winter. (November to

Figure 3.2


January to June Wind Speed Exceedences
St. Anthony #8403400, 1953-65
Percent Exceedence
100
90
80
70
60
50
40
30
20
10
0
Knots 0 10 20 30 40 50 60 70 80
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1 129.6 148.2
Wind Speed
Jan. (9671 Obs.)
Feb. (8807 Obs.)
Mar. (9672 Obs.)
Apr. (9357 Obs.)
May (9678 Obs.)
June (9359 Obs.)
1 kt = 1.852 kph

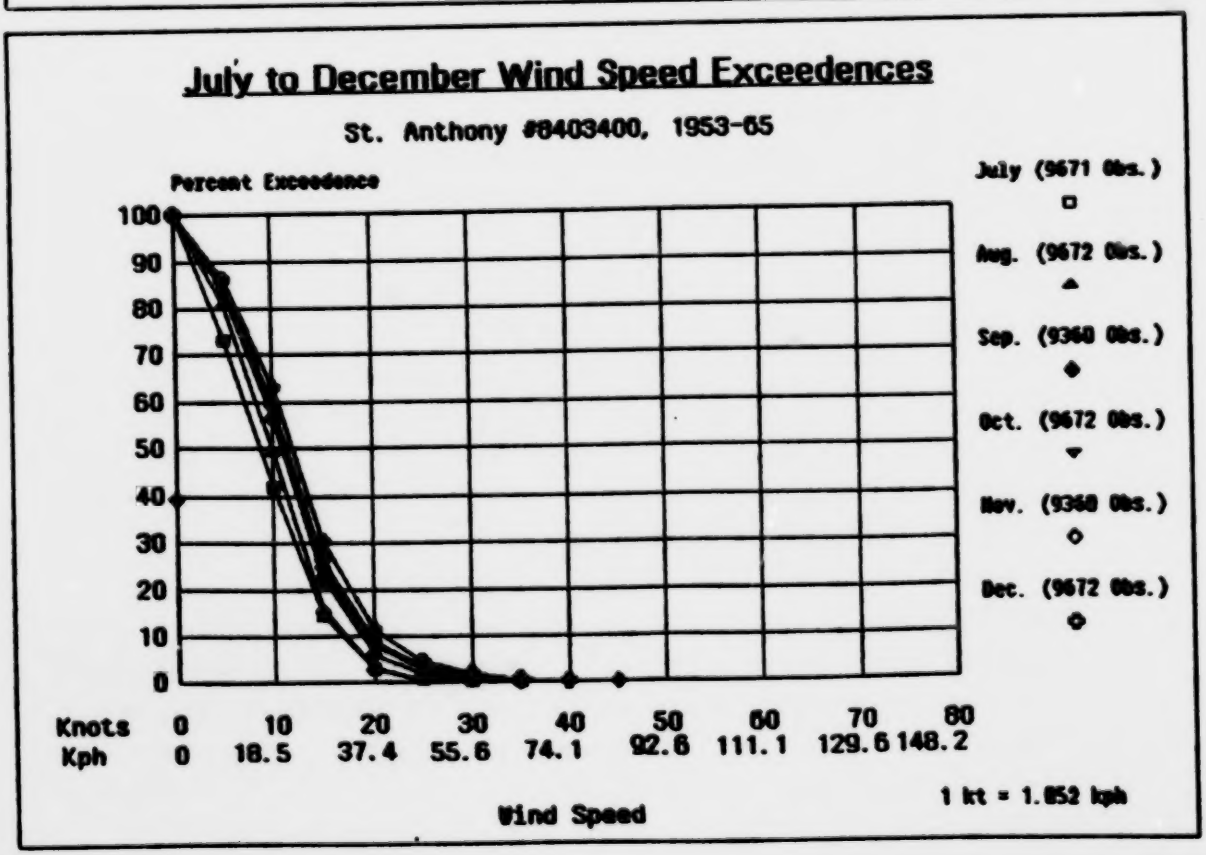
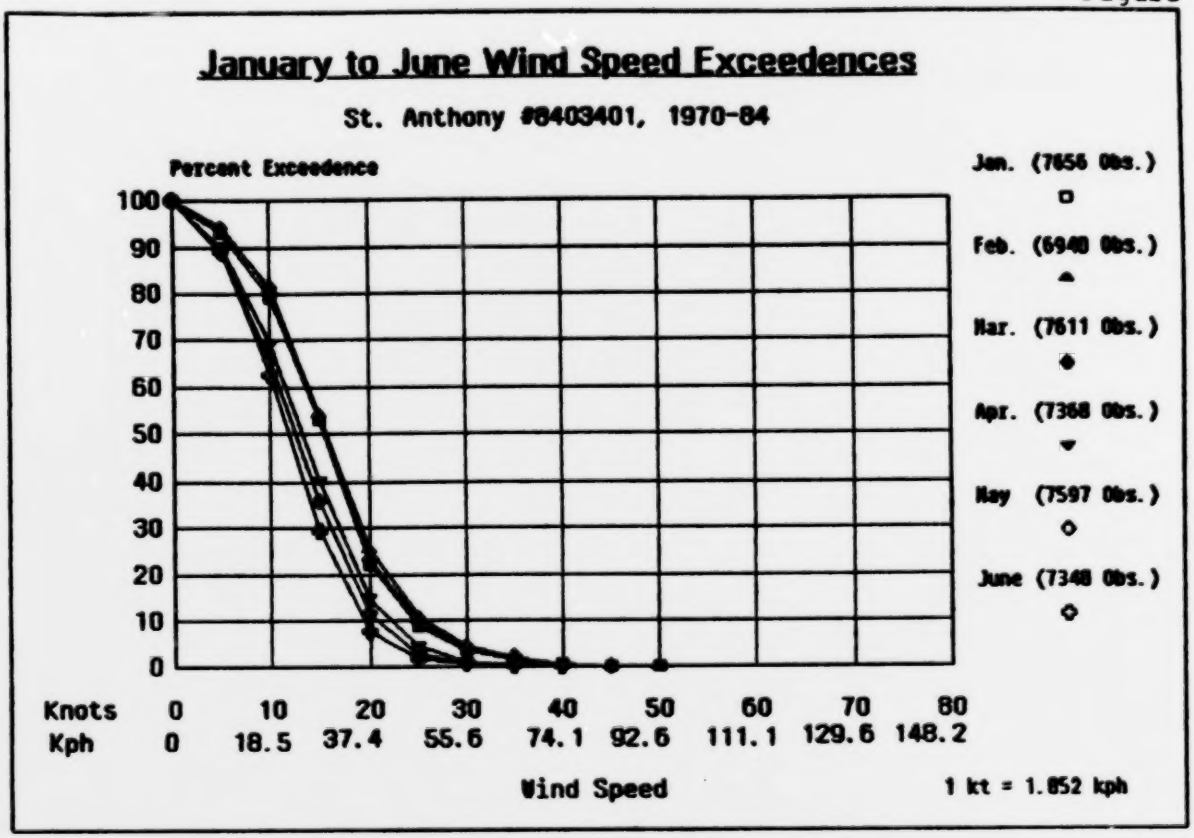

July to December Wind Speed Exceedences
St. Anthony #8403400, 1953-65
Percent Exceedence
100
90
80
70
60
50
40
30
20
10
0
Knots 0 10 20 30 40 50 60 70 80
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1 129.6 148.2
Wind Speed
July (9671 Obs.)
Aug. (9672 Obs.)
Sep. (9360 Obs.)
Oct. (9672 Obs.)
Nov. (9360 Obs.)
Dec. (9672 Obs.)
1 kt = 1.852 kph

Figure 3.3


January to June Wind Speed Exceedences
St. Anthony #8403401, 1970-84
Percent Exceedence
100
90
80
70
60
50
40
30
20
10
0
Jan. (7656 Obs.)
Feb. (6940 Obs.)
Mar. (7611 Obs.)
Apr. (7368 Obs.)
May (7597 Obs.)
June (7348 Obs.)
Knots 0 10 20 30 40 50 60 70 80
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1 129.6 148.2
Wind Speed
1 kt = 1.852 kph

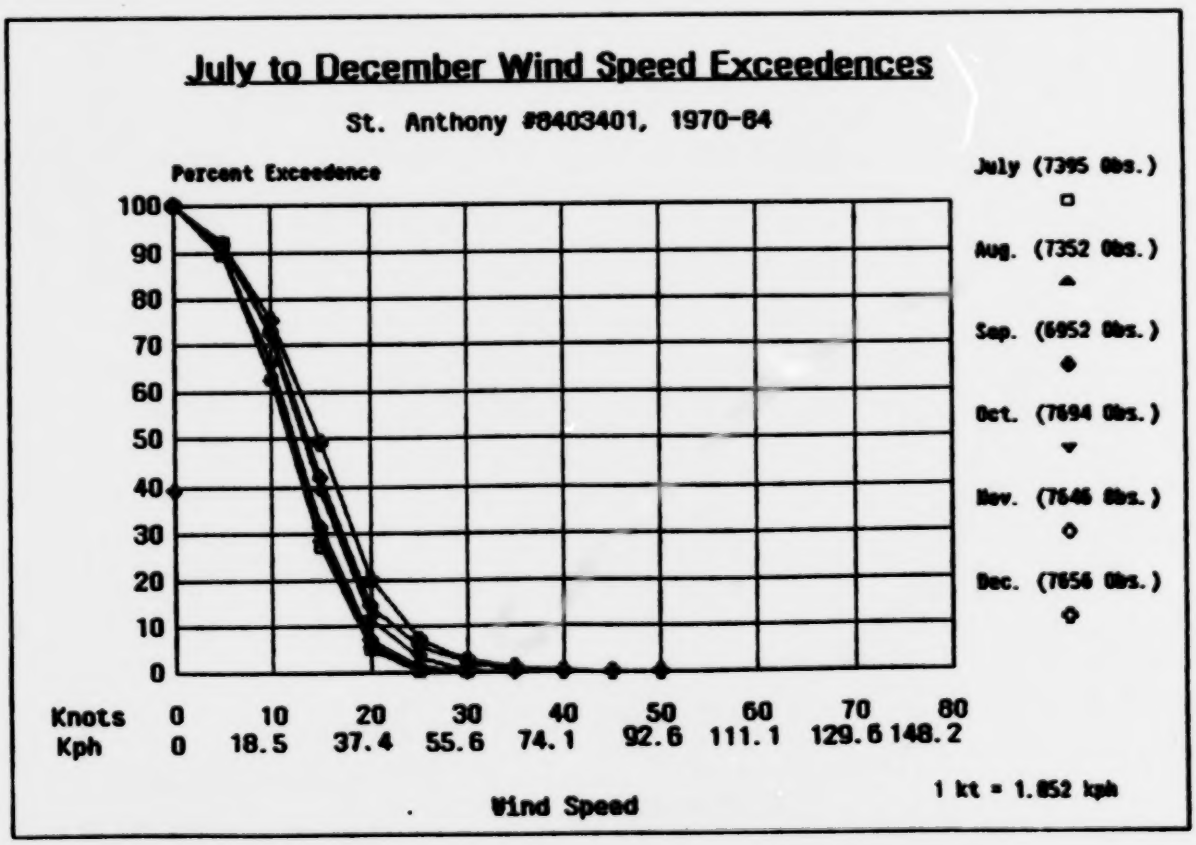
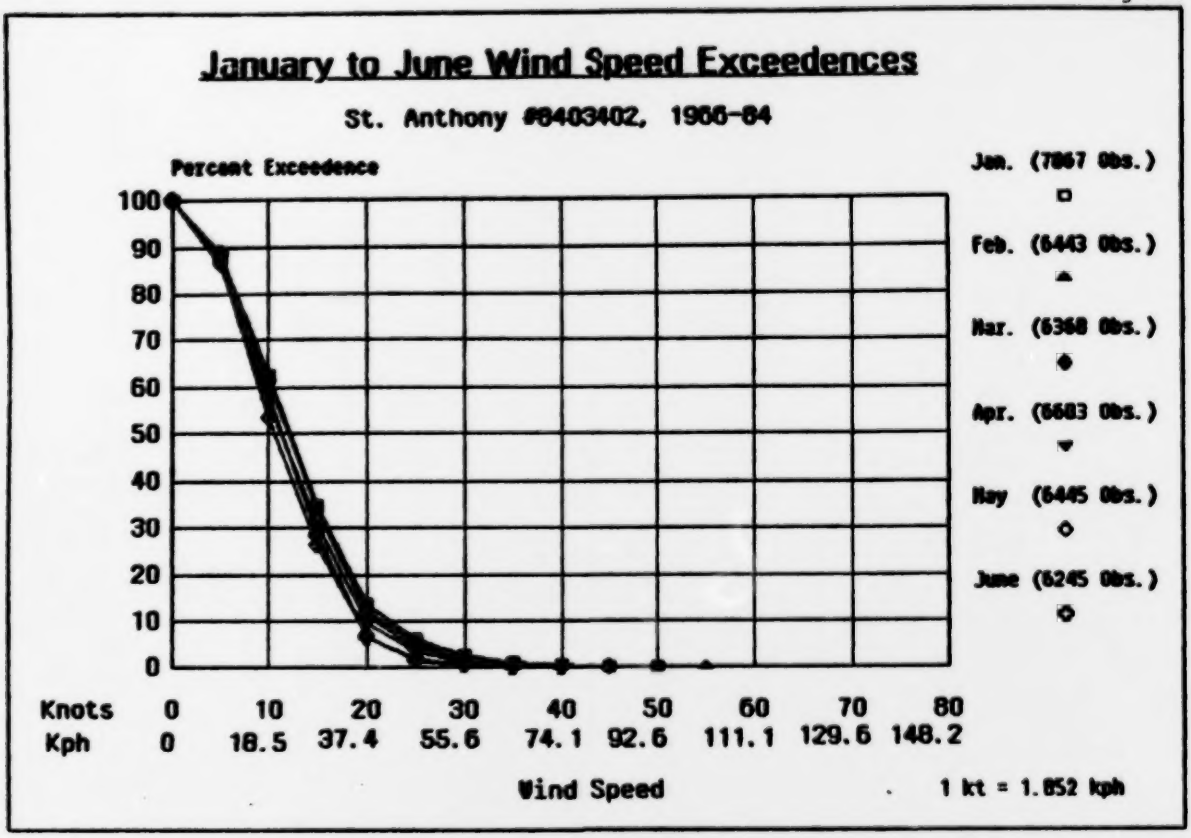

July to December Wind Speed Exceedences
St. Anthony #8403401, 1970-84
Percent Exceedence
100
90
80
70
60
50
40
30
20
10
0
July (7395 Obs.)
Aug. (7352 Obs.)
Sep. (6952 Obs.)
Oct. (7694 Obs.)
Nov. (7646 Obs.)
Dec. (7656 Obs.)
Knots 0 10 20 30 40 50 60 70 80
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1 129.6 148.2
Wind Speed
1 kt = 1.852 kph

Figure 3.4


January to June Wind Speed Exceedences
St. Anthony #8403402, 1966-84
Percent Exceedence
100
90
80
70
60
50
40
30
20
10
0
Knots 0 10 20 30 40 50 60 70 80
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1 129.6 148.2
Wind Speed
1 kt = 1.852 kph
Jan. (7867 Obs.)
Feb. (6443 Obs.)
Mar. (6368 Obs.)
Apr. (6683 Obs.)
May (6445 Obs.)
June (6245 Obs.)

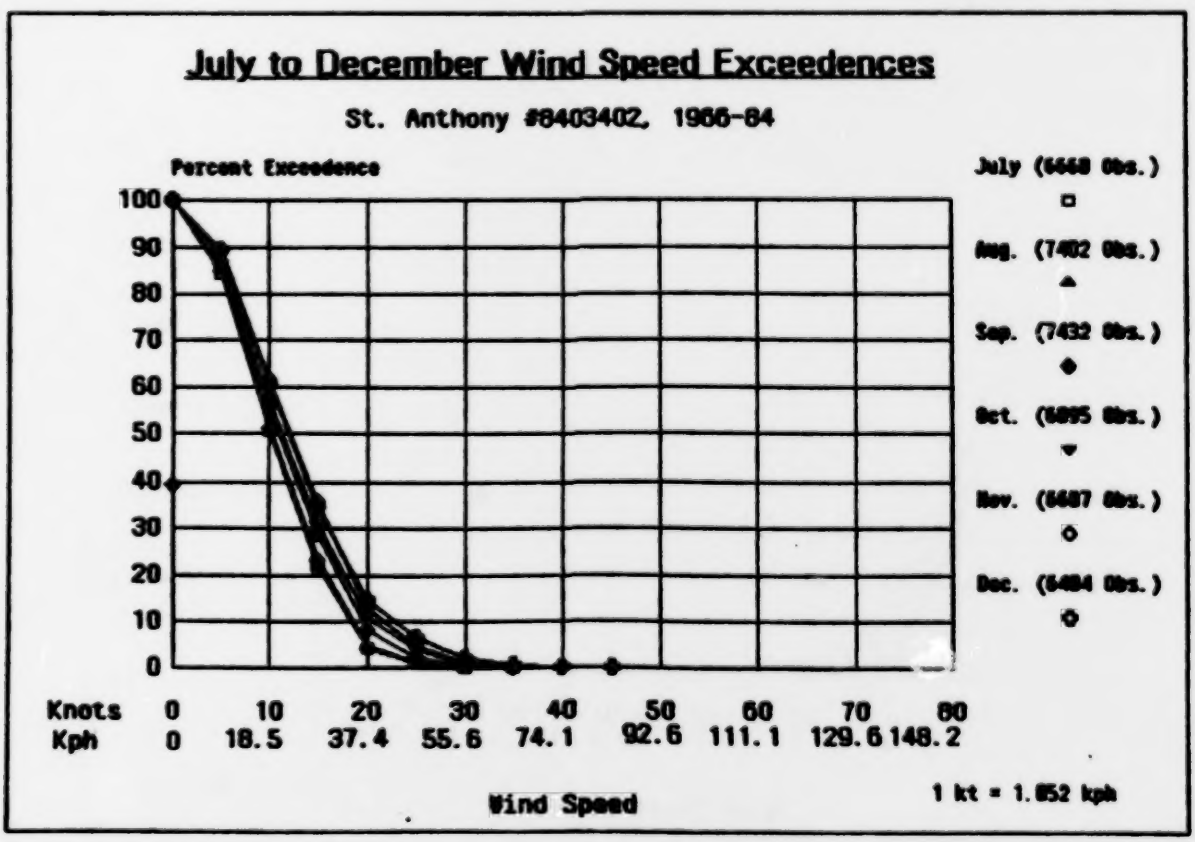

July to December Wind Speed Exceedences
St. Anthony #8403402, 1966-84
Percent Exceedence
100
90
80
70
60
50
40
30
20
10
0
Knots 0 10 20 30 40 50 60 70 80
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1 129.6 148.2
Wind Speed
1 kt = 1.852 kph
July (6668 Obs.)
Aug. (7402 Obs.)
Sep. (7432 Obs.)
Oct. (6895 Obs.)
Nov. (6687 Obs.)
Dec. (6484 Obs.)

Table 3.1 Summary of Wind Statistics from the Three St. Anthony Stations.

MONTH	St. Anthony #8403400, 1953–65				St. Anthony #8403401, 1970–84				St. Anthony #8403402, 1966–84			
	Wind Speed (knots)			Most Frequent Direction	Wind Speed (knots)			Most Frequent Direction	Wind Speed (knots)			Most Frequent Direction
	Median	Max.	No. of Obs.		Median	Max.	No. of Obs.		Median	Max.	No. of Obs.	
January	13 (24)	43	9671	W	16 (30)	50	7656	W	13 (24)	53	7067	SW
February	13 (24)	42	8807	W	16 (30)	52	6940	W	12 (22)	61	6443	SW
March	13 (24)	49	9672	N	16 (30)	52	7611	W	12 (22)	45	6368	SW
April	12 (22)	43	9357	N	14 (26)	39	7368	NE	11 (20)	38	6603	SW
May	10 (19)	45	9670	N	13 (24)	42	7597	SW	11 (20)	35	6445	NE
June	9 (17)	33	9359	W	12 (22)	40	7348	SW	11 (20)	36	6245	SW
July	8 (15)	35	9671	SW	12 (22)	30	7395	SW	10 (19)	34	6668	SW
August	10 (19)	35	9672	SW	12 (22)	30	7352	SW	10 (19)	38	7402	SW
September	12 (22)	52	9360	W	12 (22)	38	6952	SW	11 (20)	42	7432	SW
October	12 (22)	38	9672	W	13 (24)	45	7694	SW	11 (20)	36	6895	SW
November	12 (22)	42	9360	W	13 (24)	45	7646	W	12 (22)	40	6687	SW
December	13 (24)	42	9672	W	15 (28)	50	7604	W	12 (22)	43	6404	SW

Note: The above Median values were estimated from the exceedence plots. Equivalent speeds in kph are given in parentheses.

March), the North in early spring (April to May), and the West and Southwest in summer through to the fall (June to O October). The wind statistics for Cape Norman from May 17 to July 31, 1982, are shown in Table 3.2.

Figures 1 to 10 in Appendix 3 compare wind speed exceedence and distribution, respectively, between Cape Norman and the three St. Anthony (AES) stations for each month of May, June, and July.

Figure 3.5 indicates that at stations #8403400 and #8403402 the minimum wind speed was greater than or equal to 20 kph (approximately 10.2 knots) for 56% of the time, while at station #8403401 for 70% of the time. Figure 3.6 shows combined wind speed and direction distribution for the three (3) stations from January to December.

Long term wind statistics were only available for the area in general. Statistics for individual sites were not available. Hence, all sites were considered to have the same potential in the windfield category of the Decision Matrix. The average windspeed for the Belle Isle region exceeds the 12 mph. (20 kph) minimum as specified in the Assessment Methodology. Consequently, each site was given a "Yes" rating in the Matrix for having sufficient wind resources to power a WECS.

3.1.2 Topography

The topography of the land is a very important consideration in site selection. For this Assessment, the ideal site was considered to be on a hill with no terrain features within a 10 km radius that have a higher elevation. Such a site would be exposed to wind from all

TABLE 3.2

Wind Statistics

Canada Coast Guard

Cape Norman, 1982

Month	Wind Knots				Most Frequent Direction
	Median	Max.	Mean	No. Obs	
May	15(31)	40	14(26)	89	W
June	15(31)	65*	11(24)	229	NE
July	16(33)	40	10(19)	242	SW

* one isolated observation

Note: For Median and Mean values above, the speed in kph is given in parentheses.

Figure 3.5

January to December Combined Wind Speed Exceedences

St. Anthony #8403400 (1953-65), #8403401 (1970-84) and #8403402 (1966-84)

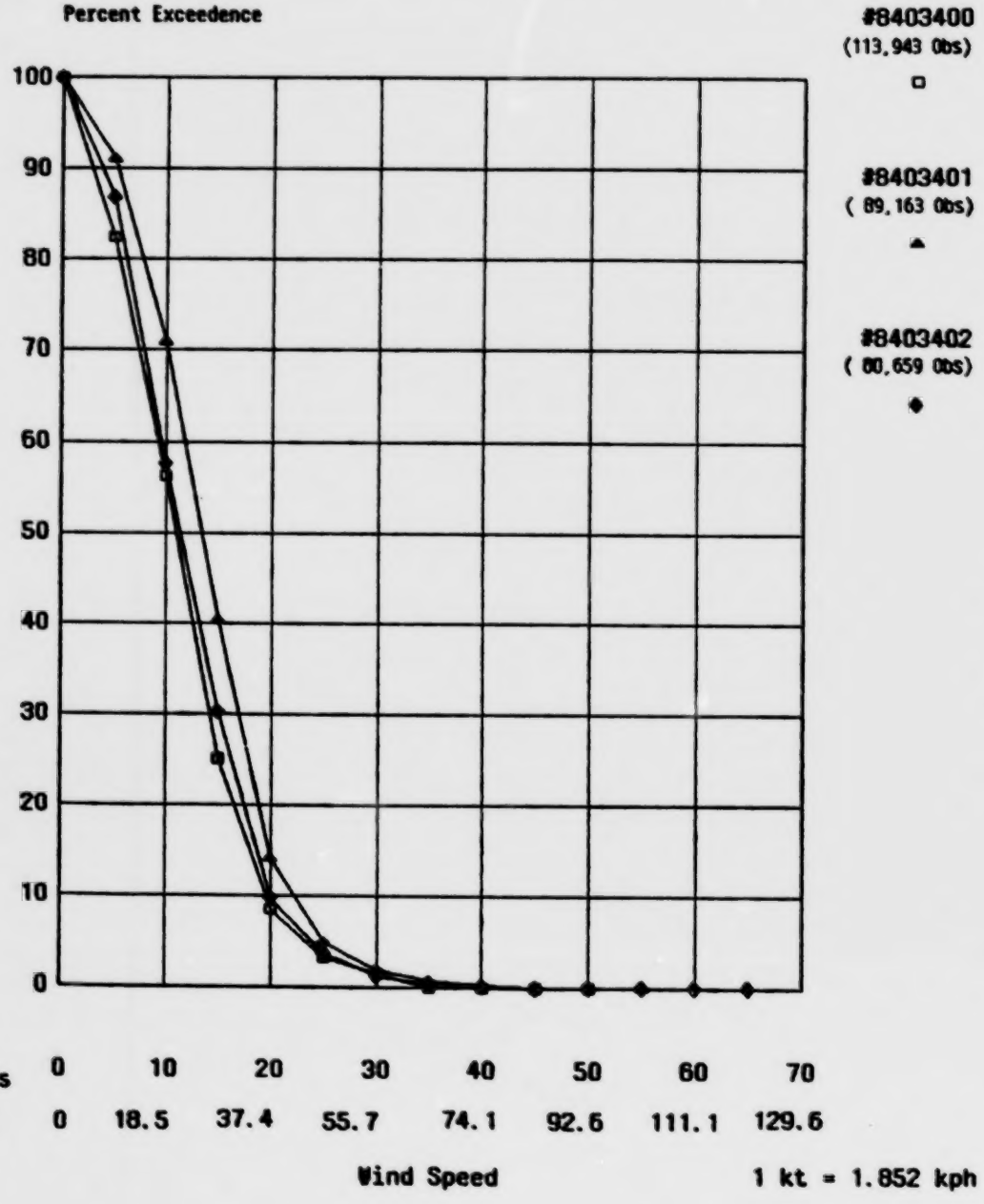
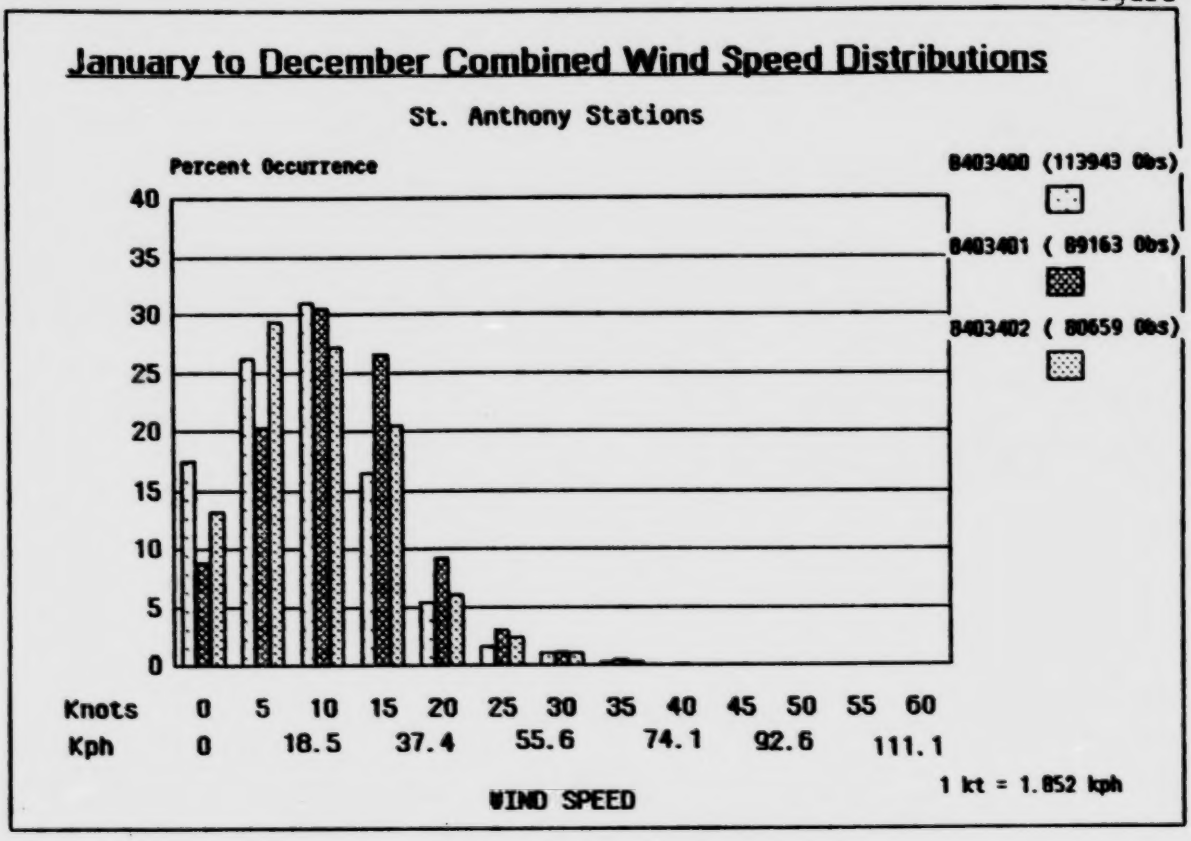
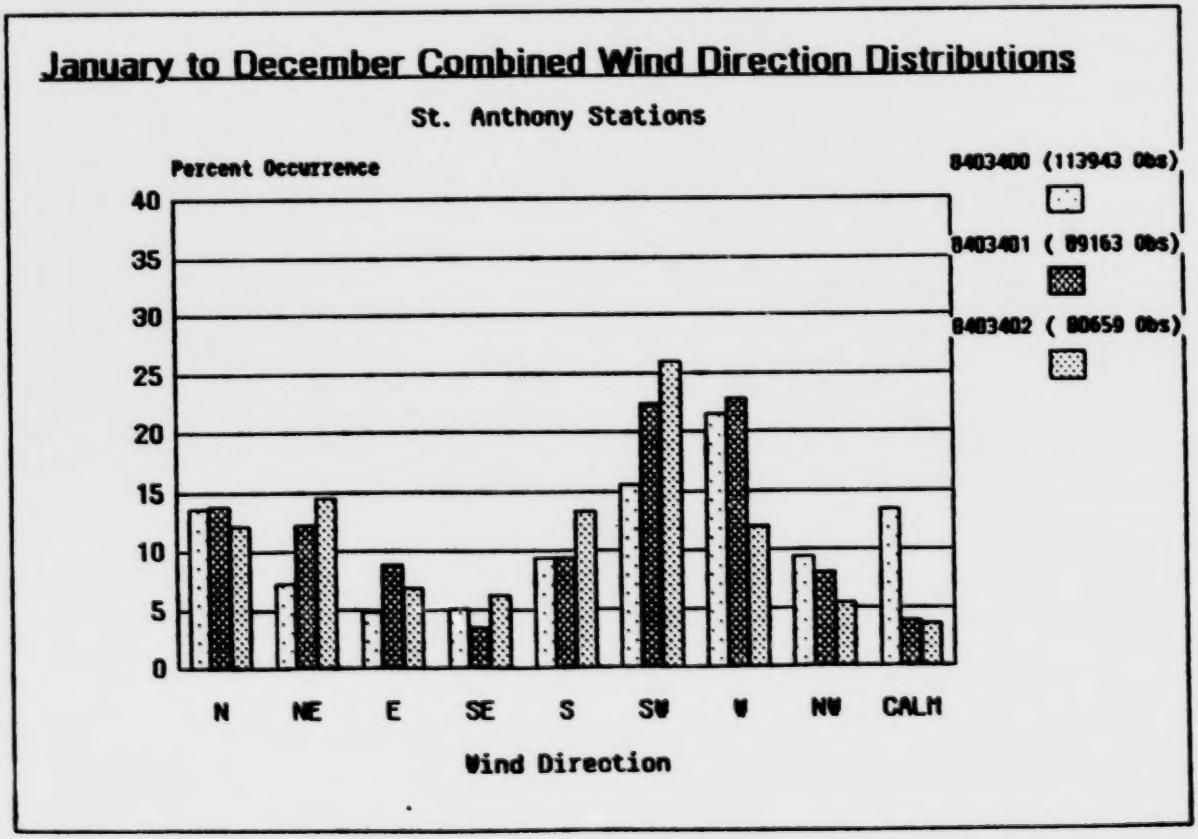


Figure 3.6


January to December Combined Wind Speed Distributions
St. Anthony Stations
Percent Occurrence
8403400 (113943 Obs)
8403401 (89163 Obs)
8403402 (80659 Obs)
40
35
30
25
20
15
10
5
0
Knots 0 5 10 15 20 25 30 35 40 45 50 55 60
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1
1 kt = 1.852 kph
WIND SPEED


January to December Combined Wind Direction Distributions
St. Anthony Stations
Percent Occurrence
8403400 (113943 Obs)
8403401 (89163 Obs)
8403402 (80659 Obs)
40
35
30
25
20
15
10
5
0
N NE E SE S SW W NW CALM
Wind Direction

directions, and the wind would be fast and smooth flowing (low turbulence).

The province of Newfoundland has a rugged topography. Hills, ridges, and mountains cover the countryside. Large, flat, open areas are rare in the Province. It is extremely difficult to locate a site near roads and transmission lines that is easily accessible and that is higher than the surrounding area in a 10 km radius. Most of our initial selections have higher points of land in the surrounding area. The purpose of the Decision Matrix is to anticipate how the obstruction will affect the windfield.

The point allocation was based on two sources of information. Wind speed and direction distribution graphs for the region were plotted showing the prevailing winds. A 10 km profile was also plotted for each site through the highest point of land surrounding it. Topographic maps (1:50,000) were used to draw the profiles. These land profiles are found in Appendix 4.

Points were awarded according to the guidelines outlined in the Assessment Methodology.

3.1.3 Safety

In designing a WECS, there is an obligation to ensure the protection of the health, safety, and welfare of others. Potential dangers include electical shock, thrown ice, flying rotor blades, and the collapse of the structure.

A fence surrounding the site will significantly reduce the risk of accidents. However, it is recommended that a WECS site be situated at least 750 ft. (230m) from the nearest dwelling.

The safety factor in this study was considered before the matrix evaluation. All of the initial sites were chosen such that the nearest dwelling was a minimum of 750 ft. away. Consequently, safety became a design constraint rather than a determining factor in the matrix evaluation.

3.1.4 Icing

Atmospheric ice accretion on wind turbine blades, towers, and transmission lines can affect the efficiency and continuous operation of the installation, and, if of significant severity, may cause structural damage. There are two kinds of atmospheric icing, rime ice caused by freezing fog or frost and glaze ice caused by freezing rain or drizzle. Rime is usually less dense and therefore is not as potentially hazardous as a severe accumulation of freezing precipitation might be. The extensive damage to power lines and poles caused by the sleet storm which struck the Avalon Peninsula on April 13, 1984, is an extreme example of the hazards of ice accretion.

Historical information on icing for the St. Anthony area was obtained through Atmospheric Environment Service (AES) in the form of freezing precipitation analyses and also through Newfoundland Hydro in the form of icing observation logs from March, 1977, to March, 1980.

Frequency of Occurrence

Tables 3.3 and 3.4 show the average number of days and the range of days with freezing precipitation for each month and annually for two different AES reporting stations in St. Anthony. Taking the extreme values from the second table, one might expect to see machine shutdown an average of 30, and up to 40 days per year. The worst months for

TABLE 3.3

Freezing Precipitation
St. Anthony - Station #1, 1957-1965 (9 years)

Month	Average No. of Days/Month with Freezing Precipitation	Range of Days with Freezing Precipitation
January	4	0-8
February	3	0-7
March	4	1-8
April	3	0-6
May	1	0-2
June	<1	0-1
July	<1	0-1
August	0	0
September	<1	0-1
October	<1	0-1
November	1	0-2
December	3	0-6
Jan. - Dec.	19	5-27

TABLE 3.4

Freezing Precipitation
St. Anthony - Station #2, 1971-1980 (10 years)

Month	Average No. of Days/Month with Freezing Precipitation	Range of Days with Freezing Precipitation
January	4	0-6
February	3	0-8
March	6	1-11
April	6	0-10
May	4	0-9
June	<1	0-2
July	0	0
August	0	0
September	0	0
October	<1	0-1
November	2	1-5
December	5	1-9
Jan. - Dec.	30	19-40

freezing precipitation and potential icing build-up are from December to April, with March being the worst month overall.

Figure 3.7, also from AES shows an isotimic chart illustrating average number of hours of freezing precipitation per year. The St. Anthony region falls between twenty-five (25) and fifty (50) hours annually, according to this chart.

For periods during 1977-1980, Newfoundland and Labrador Hydro monitored ice build-up on a specially designed passive ice meter (see Figure 3.8). This meter was installed at the abandoned Pine Tree Radar site near St. Anthony. The records are limited in that they only span the months of October to April each year from 1977-1980, and of these, monthly records are missing for ten (10) out of twenty-eight (28) months (36%) (Table 3.5). Of the remaining monthly records, some are incomplete. These observations, however, appear to be the only organized effort to directly record ice accretion. Table 3.4 shows the average number and range of days of icing deposits for each month and for each annual October to April period for St. Anthony.

It appears icing is a potential hazard in the St. Anthony area. A wind energy conversion system may have to be shut down for short periods of time if excessive icing occurs. Since icing information is only available for the area as a whole, each site scored the same point value for this item in the Decision Matrix. It is unlikely that 200 events of freezing precipitation will occur in a given year. As a result, each site scored maximum points for this item.

The amount of icing for the worst ice storms may prove to be a more useful consideration than the number of

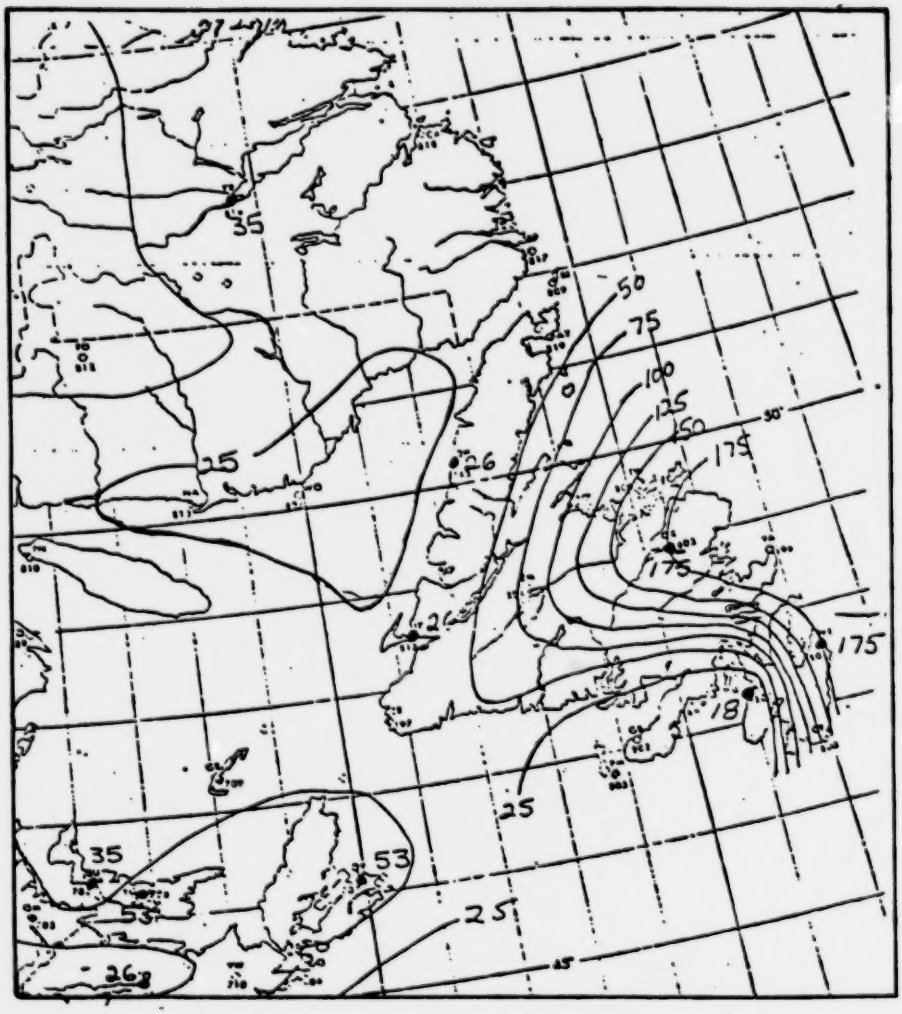


Figure 3.7 Isotimic Chart depicting average number of hours of freezing precipitation per year in the Atlantic Provinces.

PASSIVE ICE-METER

Figure 3.8

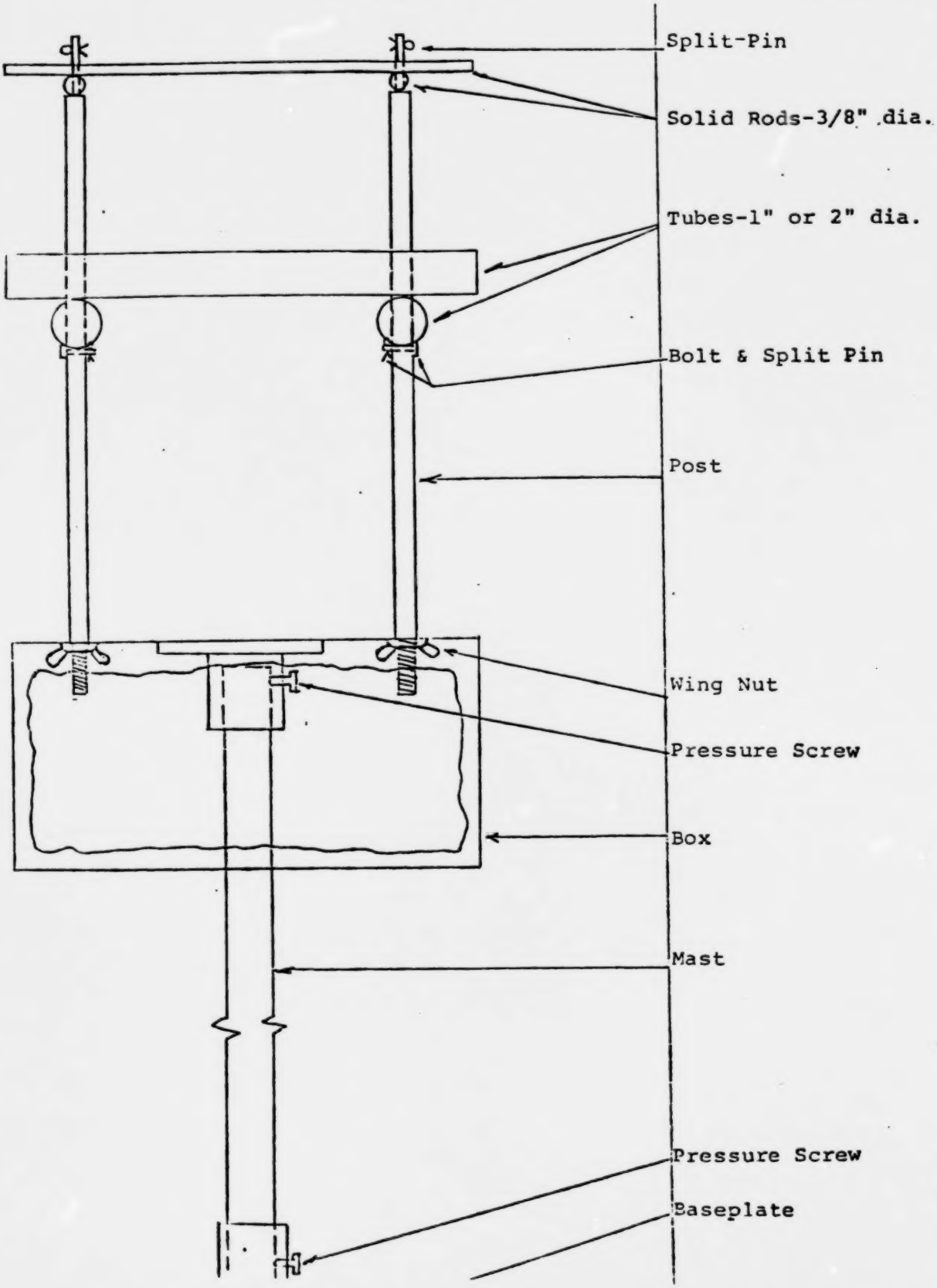


TABLE 3.5

Icing Deposits from 1977-1980
St. Anthony Area (Newfoundland & Labrador Hydro Data)

Month	Average No. of Days/Month with Icing Deposit	Range of Days with Icing Deposit
January	2	0-3
February	1	0-3
March	1	0-2
April	3	1-4
May	-	-
June	-	-
July	-	-
August	-	-
September	-	-
October	-	0-1
November	<1	0-1
December	2	1-5
Jan. - Dec.	6	2-12

occurrences of freezing precipation for this area. In any event, the collection of specific site data, in Phase II should include provisions to monitor icing.

3.1.5 Soils and Geology

The geology of a site is a necessary consideration in site selection since it determines the ease in which the WECS can be constructed. Topographic maps and aerial photographs provided this information for the desk study. Confirmation was made, where possible, during the field visit. Snow cover caused visual restriction in many cases.

There are four (4) basic types of surface conditions found in the province of Newfoundland: thinly covered bedrock, till, bog, and forest. Smooth bedrock is ideal for a WECS site since site preparation is limited, and no major foundation work is required. Construction on till requires site preparation and a foundation. Bog is less favourable since in site preparation, it will have to be removed and in some areas, replaced by more suitable material. Site selection in a forested area was avoided since higher towers are required in order to reduce the sheltering effect and turbulence caused by the surrounding trees.

3.1.6 Equipment and Skill Availability

The availability of Equipment and Skill was not of major importance in choosing the best sites from the initial selection. Heavy equipment, skilled operators, and labourers are readily available in the Town of St. Anthony and the surrounding areas. Furthermore, all sites are a short distance, by road, from the Town. Therefore, in evaluating this item in the Decision Matrix, all of the initial sites were judged to have all necessary equipment and skill available.

3.1.7 Access

With the exception of the available wind resource, site access may prove to be the most important factor in final site selection. Road construction to a site often plays a fundamental role in determining the economic feasibility of any project.

For the purpose of this study, all of the proposed areas were considered to have equal accessibility by sea, road, and air. This is primarily due to the fact that any two (2) sites are separated by less than an hour by road. As a result, the only concern in this evaluation was whether or not an access road must be constructed to the specific site.

All of the initial sites would require construction or upgrading of access roads. Therefore, in this category, each site would have been awarded the same points in the Decision Matrix. This meant deviating from the guidelines set forth in the assessment methodology for this item.

A rough cost estimate was made for the construction of access roads to each of the sites. The estimates were based on topographic maps (scale 1:50,000), aerial photographs, and site photographs from the field visit. A detailed cost estimate was beyond the scope of the study, and was not necessary for the evaluation. The main concern was a "ballpark" figure that could be used as a basis for comparison and point allocation.

The new point system for this item is as follows:

The site requiring the least expensive road was awarded 25 points. The site requiring the most expensive construction

did not receive any points. Points for the other sites were awarded on the basis of their relative costs, between the most expensive and least expensive access roads. The scores were rounded to the nearest five (5) points.

3.1.8 Social Impacts

Social aspects associated with the construction and installation of a WECS should prove to be positive. Short-term jobs for operators and labourers should result from road construction and tower erection. Long-term jobs will be created for the operation and maintenance of such a system, particularly if more than one WECS is installed.

At present, there are no major wind developments in the province. Interest in such a system should prove to be great, and not only in the St. Anthony area. A probable spinoff from such a project would be an increase in tourism spurred by curiosity, although it may be slight.

The St. Anthony area is largely underdeveloped with the majority of the hills and ridges along the coast remaining undeveloped. Local residents may not be pleased with the aesthetics of such a project if it were poorly situated. Safety may also be a concern of the residents. However, if the system is carefully designed, the positive economic and social benefits will outweigh these potential negative impacts.

Social impacts in all areas of the study are expected to be similar since we are dealing with a small interconnected area rather than a group of remote and isolated communities. Consequently, all sites were awarded the maximum points.

It is likely, however, that the Town of St. Anthony will benefit more than the other communities, regardless of which site is selected. The Town has the best selection of heavy equipment and skilled operators, and is the economic centre of the region. Furthermore, since the regional base of operation of Newfoundland and Labrador Hydro is located in St. Anthony, base operations of installed WECS in the area will most likely be in the Town as well.

3.1.9 Acquisition

Acquisition of land is of prime importance in final selection of sites. In most cases, the site was on crown land which is readily available for lease or purchase (Appendix 5). Costs for such aquisition are minimal.

In this study, we made one deviation from the Assessment Methodology. If for some reason the site was privately owned, and acquisition was either unfeasible or not possible, the site was disqualified rather than awarded no points. This happened for two (2) sites just outside of St. Anthony. Both had communication towers on the summit of the hills.

3.1.10 Demonstration Visibility

Demonstration visibility is important in this study because the project may be the first of its kind in the province. However, this item is not a deciding factor in the matrix evaluation. We are dealing with a small region in which each area is easily accessible by road, thus each site can be considered to have equal demonstration visibility. The population of St. Anthony alone is large enough to justify the maximum number of points for each of the proposed locations.

3.1.11 Electromagnetic Interference

A WECS is a potential source of electromagnetic interference, primarily in microwave and television interference. For example, medium and large systems, with metal blades, may scatter television signals and interfere with local television reception. Sites can only be selected if they are not in a direct line of transmission.

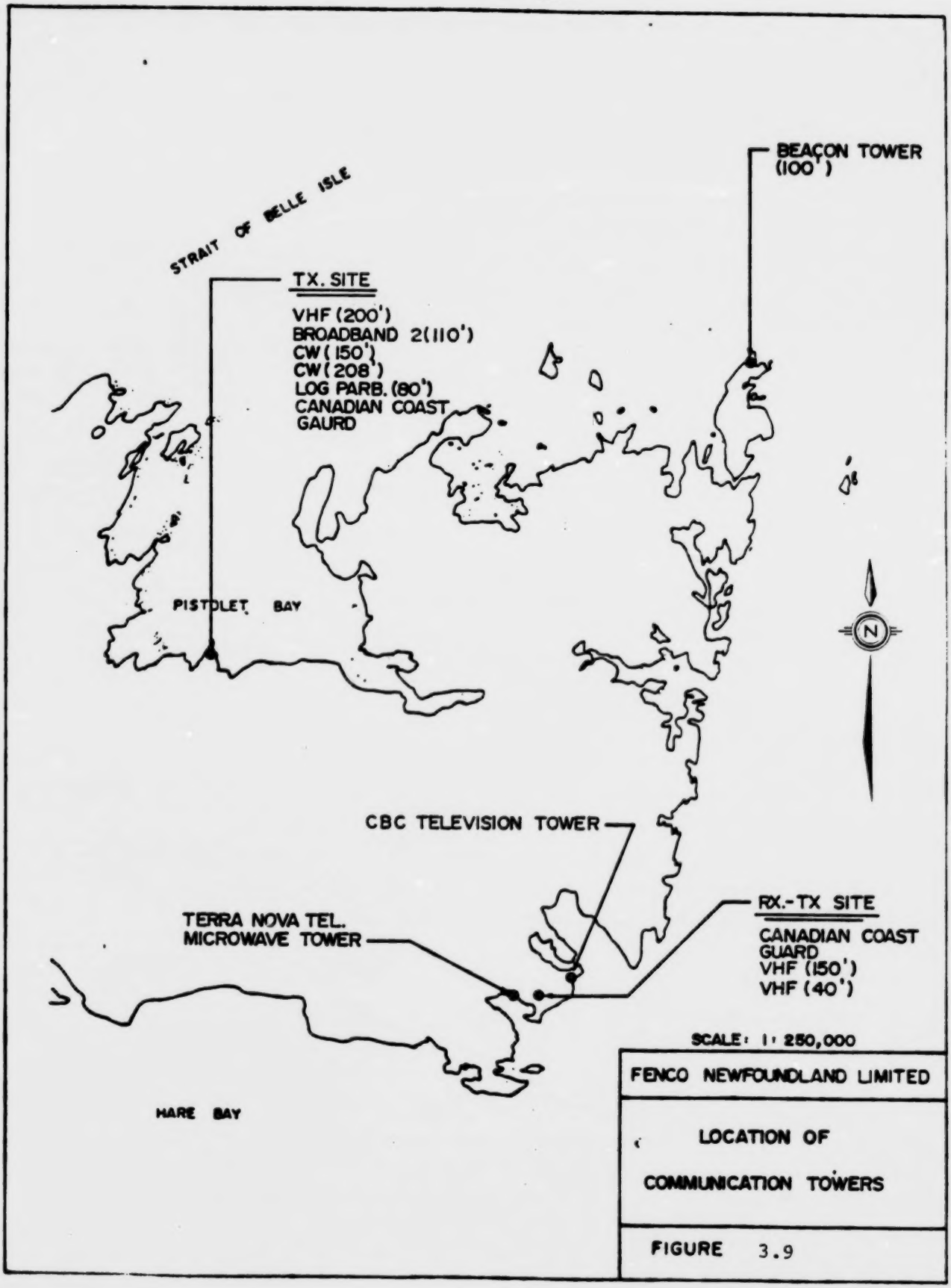
The locations of all transmitting and receiving towers in the region were obtained from the Canadian Coast Guard, and the Department of Communications (Appendix 6). Possible interference will depend on several factors, including the type of WECS to be erected and the materials used in rotor construction.

The line of transmission was estimated for the purpose of this matrix evaluation. Further study will be required to determine the possible interference. Conclusions cannot be drawn from the line of transmission alone. Figure 3.9 shows the location of the communication towers in the St. Anthony area.

3.1.12 Connection Distance

The connection distance is the length of transmission line that is required to connect the WECS to the existing distribution lines. This is another important factor in economic feasibility determination. For the purpose of this evaluation, we assumed that the line will follow the access roads, and thus, site conditions are not critical in transmission line construction. The distances were obtained from 1:50,000 topographic maps.

The Assessment Methodology does not consider whether the existing distribution lines are single phase or three


BEACON TOWER
(100')
STRAIT OF BELLE ISLE
TX. SITE
VHF (200')
BROADBAND 2(110')
CW (150')
CW (208')
LOG PARB. (80')
CANADIAN COAST
GAURD
PISTOLET BAY
N
CBC TELEVISION TOWER
RX.-TX SITE
CANADIAN COAST
GUARD
VHF (150')
VHF (40')
TERRA NOVA TEL.
MICROWAVE TOWER
HARE BAY
SCALE: 1: 250,000
FENCO NEWFOUNDLAND LIMITED
LOCATION OF
COMMUNICATION TOWERS
FIGURE 3.9

phase. This is an important consideration in electrical generation, and is addressed in the final assessment.

3.1.13 Minimum System Demand

Minimum system demand is another item in the matrix that was not a deciding factor in the evaluation. This was because all areas in question are on the same electric grid, where the minimum load is 1500 kW, and hence much higher than the 60 kW specified in the Assessment Methodology. As a result, each site was awarded the maximum point score.

3.1.14 Wind Farm

The St. Anthony diesel plant, with a firm capacity of 6 MW, provides electricity for many communities in the region, and thus, the minimum system demand is quite high. As a result, a number of wind systems could be utilized to reduce the demand on diesel generated energy.

It may prove to be advantageous to construct several WECS in the area. Often it is more feasible to construct several small units than one large one. Such a site, containing more than one unit is called a wind farm. The size of a proposed site was considered in this study in the event that a wind farm proves to be viable.

The required spacing is impossible to determine since the type and size of the WECS is beyond the scope of the study. However, the sites were divided into two (2) categories. First, a large open site that could accommodate more than one unit was awarded five (5) points. The smaller site that would probably only be able to accommodate one system were not awarded any points. Note that this item was not given a heavy weighing since the idea of a wind farm is only a possibility.

3.1.15 Fuel Costs

The "Site Assessment Methodology" suggests that unit fuel cost for each community be used as a biasing tool to: decide between sites of similar weighing scores, assist in determining whether a community with a relatively low score may have some potential on the basis of cost savings, and provide a feel for the expected economics of an installation. The higher the cost of fuel, the more economical the installation will be and consequently, the more attractive the site will be for a WECS installation. It also suggests that this cost parameter not be weighed but, rather be applied as necessary as a bias after the sites have been otherwise evaluated.

In the case of site assessment for the St. Anthony area, this rational was not applied. The energy produced by a WECS from any of the sites will be feeding into the same grid and therefore, no differential fuel costs are involved.

The cost of producing electrical energy from diesel power is expensive in comparison to other modes of operating. In the final economical feasibility analysis for deciding whether or not to install a WECS on a particular site, the cost of diesel fuel will be one of the principle parameters used.

3.2 Initial Site Selection

The initial step in the Desk Assessment was to identify a number of sites to investigate. This selection was based on four (4) principle criteria: road access, transmission distance, exposure to wind, and geotechnical information. This information was obtained from 1:50,000 topographic maps and air photographs of the St. Anthony area.

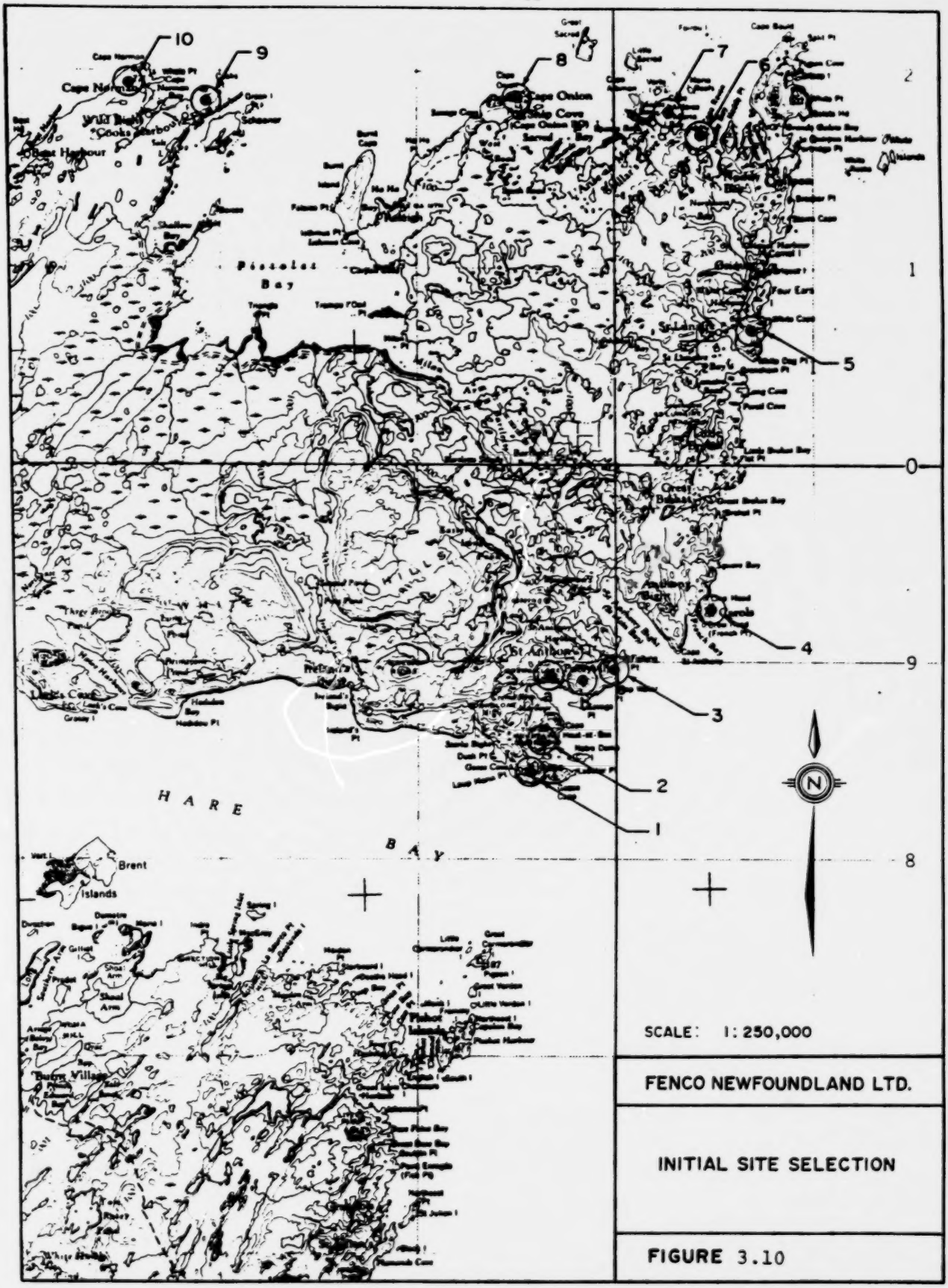
The ideal site for a wind turbine is on a rocky rise in which the land, in a 10 km radius of the site, has a lower elevation. Such a site would be exposed to largely undisturbed winds from all directions, and turbulence would be limited. The site would also be accessible by a road suitable for construction purposes, and have a transmission poleline to the summit. Finally, no other development would be present at the site.

It is highly unlikely that such a site exists. The purpose of the Assessment Methodology is to choose a location which is as similar to this ideal site as possible.

The topographic maps shows all this information with the exception of the transmission lines. The position of all the polelines in the area in question was provided by Newfoundland and Labrador Hydro, and plotted on topographic maps.

Based on this information, twelve (12) potential sites were selected to be further investigated. All of these sites have an elevation above the surrounding area, were near roads and transmission lines, and were barren and uninhabited. The initial site selections are shown in Figure 3.10.

The lack of roads and transmission lines significantly eliminated much of the land in the 40 km radius of St. Anthony. Furthermore, all of the sites were chosen near the coast so that winds from many directions will be unobstructed, and turbulence will be low.


10
9
8
7
6
5
4
3
2
1
Cape Norman
Wild Bight
Cooks Harbour
Ghost Harbour
Pistolet Bay
Three Arms
Lushs Cove
St Anthony
HARE BAY
Brent Islands
Shoal Arm
Burnt Village
N
SCALE: 1: 250,000
FENCO NEWFOUNDLAND LTD.
INITIAL SITE SELECTION
FIGURE 3.10

3.3 Aerial Photographs

Aerial photographs were obtained for each of the twelve (12) sites. These were used to determine the surface conditions, existing developments, and possible access. They were also a useful tool in identifying the sites during the field visit.

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4.0 Field Investigation

4.1 Field Verification

All twelve (12) of the initial sites were visited. The location of roads and transmission lines were confirmed while enroute to each of the sites.

In the event that an initial site selection was not the most promising in a given area, a new site was selected in a more optimum location.

Much of the ground was snow-covered during the time of the field visit, thus making visual observations difficult. Notes were taken whenever possible on terrain features.

Finally, each location was photographed in an attempt to show all relevant information.

4.2 Site Descriptions

Descriptions of the twelve (12) initial sites selected are outlined below:

Site No. 1

Site No. 1 is located on a ridge southeast of the town of Goose Cove, on the Goose Cove Peninsula. The ridge is largely a barren outcrop of rock. Access to the ridge is difficult, however, several moderate slopes are present. These would allow for access road construction. The highest portion of the ridge is further southeast, and access to this peak will be much more difficult.

Roads and transmission lines are found in the town, but not on the ridge.

Winds from the north to the northeast are blocked by a higher ridge known as Three Mountain Summits.

This site is large and uninhabited, thus a wind farm is possible.

Site No. 2

Site No. 2 is located 1.5 km northeast of Goose Cove on a ridge known as Three Mountain Summits. This is one of the highest mountains in the St. Anthony area.

The mountain is very close to the main road and transmission lines, but access to the summit is extremely difficult.

If access were possible, the site would be excellent since it it high, unpopulated, large enough for a wind farm, and the summit appears to be all rock.

Site No. 3A

This site is situated on Cremailliere Hill, just outside of St. Anthony. It is the remains of an old Pine Tree Line Radar Base. All that is left is scrap metal and several concrete foundations.

This is the highest of the hills immediately surrounding St. Anthony. It is accessible by road and there is a poleline within a few hundred feet of the summit.

The area is cleared of all rock, with the exception of the concrete foundations. The area is not large, and more than one wind turbine may not be possible.

The main drawback with this site is that three (3) communication towers are visible, with one being quite close. How a wind turbine will interfere with transmissions from these towers is uncertain.

Site No's 3B and 3C

Both of these sites are located on summits of hills just outside St. Anthony. They would make excellent locations except that there are communication towers on them, and thus, there is no room for a wind turbine.

There is a lower summit nearer the coast that has some potential. However, access by road and electrical transmission is not as good and all winds to the north will be blocked by the higher hills.

Site No. 4

This site is located on a ridge beside the town of St. Carol's, on the coast northeast of St. Anthony. It is a barren rock outcrop, and access from the community appears reasonable. Transmission distance from the community is short, and a wind farm is possible.

The problem with this site is that there is a larger ridge to the west which would partially block all winds from the southwest to the northwest.

Site No. 5

This site is located on a hill south of the community of White Cape Harbour. It is on the coast, northeast of St. Anthony. The hill is higher than the surrounding area, and access is difficult, but appears possible via an existing

footpath. The summit is barren, however, due to its small size, a wind farm would not be possible.

Site No. 6

Site No. 6 is located on a ridge known as Cape Raven, on the north coast of the Great Northern Peninsula. This ridge is barren with some shrubs and small trees. It is very close to the road and transmission lines. There appears to be sufficient area for more than one WECS.

The difficulty with this site is also access. There is one pass through the ridge in which a poleline crosses. Access to the ridge is much simpler here. A potential problem is that the town has set up a children's playground along this pass, and access may disrupt its operation.

Site No. 7

This site is located in L'Anse aux Meadows, on the coast north of St. Anthony. There are several ridges in the area with flat surroundings which would make suitable locations. The ridges are barren and most of them are rock. There is room for a wind farm.

There are two problems with this site. First, winds from the southeast would be blocked by site No. 6, Cape Raven. Second, L'Anse aux Meadows is a national historic site, and Parks Canada have indicated that a massive wind turbine will not be aesthetically pleasing in the area. Strong opposition to any visible construction in this area can be expected.

Site No. 8

This site is also on the north coast of the Great Northern Peninsula. It is situated on Cape Onion, north of the community of Ship Cove. It is the highest ridge in the surrounding area, barren, uninhabited, and there is plenty of room for a wind farm. However, a major problem with this site is that it is just over one kilometer from the main road, and estimated construction costs for an access road are higher than any other site.

Site No. 9

This site is just northeast of Cook's Harbour, on the north coast of the peninsula. It is on a gentle sloping, rocky ridge, and access for construction purposes will not be difficult. The elevation of the land increases as you go farther from the road towards the coast, ending in a cliff. However, the farther you go, the longer the access road and transmission distance will be. There is sufficient area available here for more than one WECS.

Site No. 10

This site is the northernmost of the twelve (12) sites. It is just inland of Cape Norman. The site consists of a ridge with very low land surrounding it. The area is barren and the ridge is all rock. Access to the site is easy, a road would not have to be constructed. A transmission line passes alongside the ridge. Finally, the area is large, and a wind farm is possible.

5.0 FINAL SITE SELECTION

5.1 Matrix Evaluation

The scoring for each item of the Decision Matrix totals for each site are summarized in Table 5.1. The totals, in order of ranking, are given in Table 5.2. Figure 5.1 shows the location of the four (4) sites that scored highest in the Matrix.

5.2 Final Assessment

Since the ten (10) initial sites selected in this study are in very close proximity, and are interconnected by both roads and an electric grid, only four items of the Decision Matrix were deciding factors in the final site selection. These items were Topography, Site Access, Connection Distance, and Wind Farm Possibility. The sites all received the same point score for the other items in the Matrix. This represents eighty (80) of the maximum one hundred and sixty (160) points that can be alloted. This can partially be attributed to a careful initial site selection, rather that a random selection. The initial sites were expected to score maximum points for most of the items.

Clearly, the Assessment Methodology is not designed for a region such as St. Anthony. It is primarily geared for remote and isolated communities since only four (4) items in the Matrix had an influence on the final site selection. As well, none of these four (4) items were as straightforward as they were outlined in the Assessment Methodology, so the scoring may be questioned.

TABLE 5.1

An Assessement Methodology for the preliminary selection
of Wind Energy Conversion Systems In Remote Communities
In the Province of Newfoundland and Labrador

DECISION MATRIX

Weighing Categories		Wind Field	Topo-graphy	Safety	Icing	Soils & Geology	Skill & Equipment	Access	Social Impacts	Acquisition	Demo Visibility	EMI *	Connection Distance	Min. Demand	Wind Farm	Total
Max. weight		Yes/No	Yes/No/30	Yes/No	10	10	10	25	10	10	5	15	20	10	5	160
Community	Site No.															
Goose Cove #1	1	YES	0	YES	10	10	10	5	10	10	5	15	10	10	5	100
Goose Cove #2	2	YES	20	YES	10	10	10	25	10	10	5	15	0	10	5	105
St. Anthony	3a	YES	20	YES	10	10	10	25	10	10	5	15	20	10	0	145
St. Carrol's	4	YES	20	YES	10	10	10	0	10	10	5	15	5	10	5	110
White Cape	5	YES	20	YES	10	10	10	5	10	10	5	15	5	10	0	110
Cape Raven	6	YES	20	YES	10	10	10	0	10	10	5	15	0	10	5	105
Lanse aux Meadors	7	YES	20	YES	10	10	10	20	5	5	5	15	15	10	5	130
Ship Cove	8	YES	30	YES	10	10	10	0	10	10	5	15	0	10	5	115
Cock's Harbour	9	YES	30	YES	10	10	10	20	10	10	5	15	15	10	5	150
Cape Norman	10	YES	30	YES	10	10	10	20	10	10	5	15	20	10	5	155

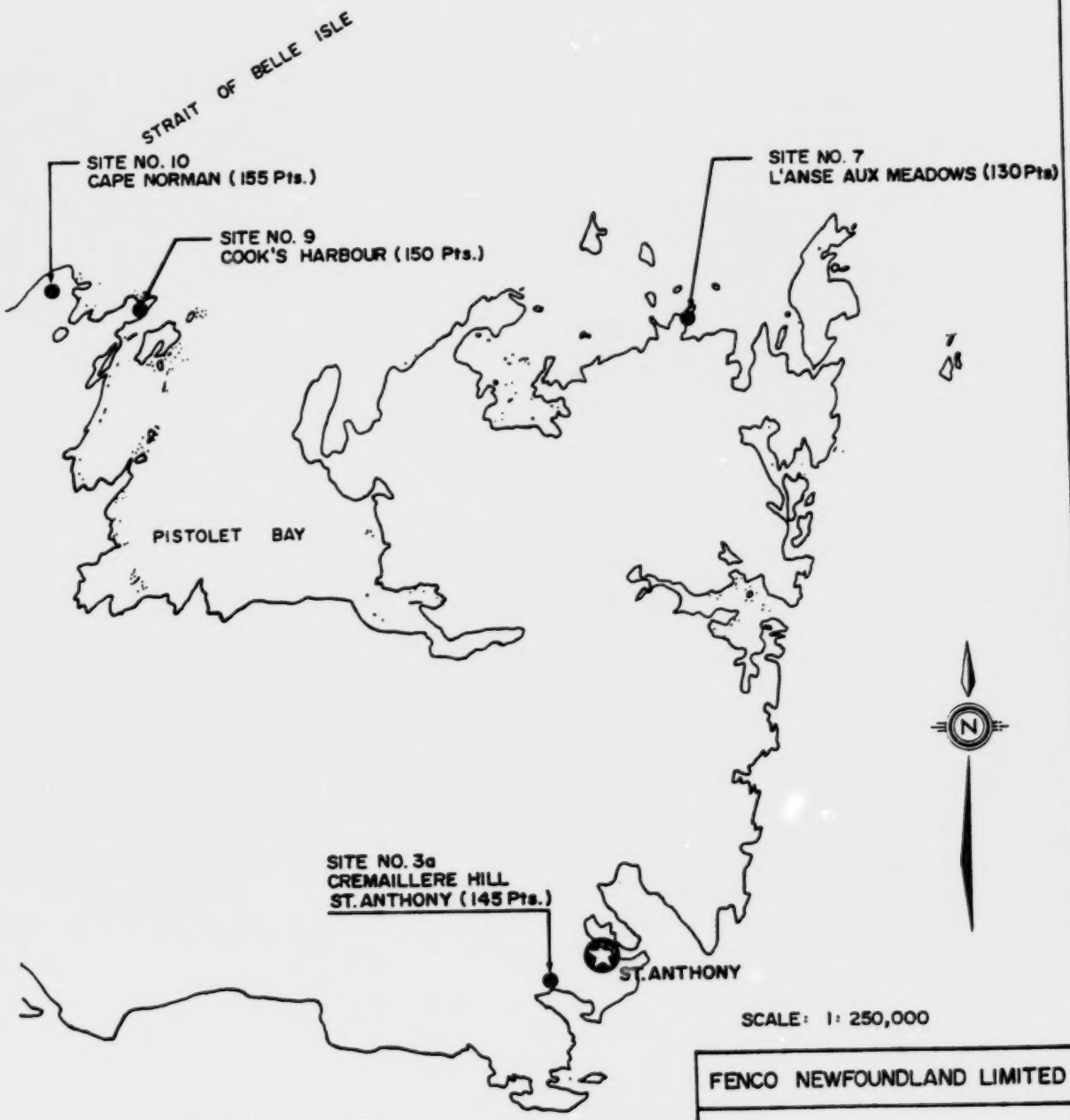
* EMI - Electromagnetic Interference

TABLE 5.2

Ranking of the Initial Sites

RANKING	COMMUNITY	SITE NO.	SCORE
1	Cape Norman	10	155
2	Cook's Harbour	9	150
3	St. Anthony	3a	145
4	L'Anse aux Meadows	7	130
5	Ship Cove	8	115
6	St. Carrol's	4	110
7	White Cape	5	110
8	Goose Cove #2	2	105
9	Cape Raven	6	105
10	Goose Cove #1	1	100

Maximum Possible Score = 160 points



SCALE: 1: 250,000

FENCO NEWFOUNDLAND LIMITED

FINAL SITE SELECTION

FIGURE 5.1

Topography is extremely hard to score if there are higher points of land within the ten kilometer radius. The amount of wind sheltering and turbulence associated with large and small scale features is a rough estimation at best. Accurate predictions cannot be based solely on 1:50,000 topographic maps and wind roses for the general area. Monitoring the wind at various elevations for each of these sites is the only accurate way to predict how topography will influence the winds.

The scoring of points for site access did not apply to this area, and thus, this item had to be rewritten. The ease, of road construction was estimated, and points were awarded on their relative difficulties. As with topography, an accurate estimation is not possible without a thorough investigation, which was beyond the scope of this study.

On the surface, connection distance appears to be straightforward, as outlined in the Assessment Methodology. Scoring was done on this basis, although the type of transmission line at the connection point, three phase or single phase, was not considered. It is more desirable to connect the WECS to a three phase line than a single phase line. This was not considered in the Assessment Methodology.

Fortunately, three phase connection did not turn out to be an important consideration in the Assessment. The sites with the top three scores were all very close to a three phase transmission line. Unlike most of the other sites, costs associated with upgrading single phase lines to three phase, will either be zero or insignificant.

The fourth item, the possibility of a wind farm, was not considered in the Assessment Methodology, but was included

in the study. However, the importance of this item is indicated by its low weighting, since the plan of having a wind farm is only a possibility.

Of the ten (10) initial sites, four (4) show a much higher potential for wind energy conversion than the others. These four (4) were Cape Norman (155), Cook's Harbour (150), Cremaillere Hill, St. Anthony (145), and L'Anse aux Meadows (130). The site scoring the next highest had only 115 points. (Table 5.1)

The L'Anse aux Meadows site ranked fourth in the evaluation Matrix. However, there are two (2) weaknesses in the location of this site which warrant comment.

Firstly, this site is further away from three (3) phase transmission lines than the top three (3) sites. Upgrading the single phase transmission line to three (3) phase will increase the overall installation cost of the WECS compared to the other three.

Secondly, during the assessment of this site, Parks Canada indicated that they have spent large sums of money on the National Historic Site, and they would strongly oppose any major construction in the immediate area. They feel that a large tower in the area would not blend into the historic surroundings of the park. Hence, they would apply pressure to prevent such a system being erected adjacent to their property.

The top three (3) sites are promising in all areas. Cremaillere Hill in St. Anthony scored slightly less than the other two (2) because it is uncertain if the White Hills to the northwest will shelter winds or create turbulence. These Hills are at a much higher elevation, and

winds blow from the northwest a high percentage of the time. If, however, the Hills do not adversely influence the wind, this may prove to be the best location. A road to the site already exists and the connection distance is very short. An added advantage is that the concrete foundation from the old American Radar Base may prove to be useful and possibility utilized for future wind site development.

Wind sheltering and turbulence is not a problem for Cape Norman and Cook's Harbour. They are very near to each other, and land in the area is flat and barren. There are no obstructions to the wind within ten kilometers. Roadwork to each site is not difficult or costly. Cape Norman scored the same points as Cook's Harbour in all categories with the exception of connection distance. The connection distance to the Cook's Harbour site is slightly greater than the Cape Norman site, hence, the five (5) point difference.

Cook's Harbour may prove to be a better site due to three phase electrical connection, even though it was the connection distance item that made it second to Cape Norman. Cook's Harbour is nearer the three phase transmission line than Cape Norman, but farther from the nearest line, which is single phase. The cost of upgrading the single phase line from Cape Norman will have to be weighed against the extra cost of erecting a longer transmission line from the proposed site in Cook's Harbour.

5.3 Evaluation of Assessment Methodology

As the title suggests, the "Assessment Methodology for a Preliminary Selection of Wind Energy Conversion System Sites in Remote Communities" has been primarily developed for remote community site assessment.

There are certain items in the matrix evaluation which are not applicable to communities served by an interconnecting electrical grid and highways. Items which were not entirely applicable to this study and require further refinement include: Windfield, Equipment and Skill Availability, Access, Social Impacts, Demonstration Visibility, Minimum System Demand, and Fuel Costs. Each site received the same, score for these items, thus could not influence site selection. The matrix is not geared for interconnected communities in a small area, as is the case in the St. Anthony area.

We feel the Assessment Methodology could be improved with several refinements. Potential problems with some of the items in question will now be examined.

Windfield

The elimination of a site, if the average annual wind speed is less than 12 mph (20 kph), is acceptable. However, the sites which have annual wind speeds in excess of 12 mph (20 kph) should be further analysed. For instance, if one site is known to have a higher annual wind speed than the others, it should receive a greater weighing. Since the potential energy from a WECS is directly portional to the cube of the wind speed, this is one of the most important considerations in determining the economic feasibility.

In the event that wind data is available for these sites which have wind speeds greater than 12 mph (20 kph), a scoring system should be included as an item in the Decision Matrix.

Equipment and Skills Availability

The scoring scheme for equipment and skill availability in the Matrix appears to be slanted towards the owner erecting the WECS with his own or local forces.

If the project is contracted, then the successful contractor may not be from the immediate area. He may choose to bring in his own equipment and skilled labour from outside of the community. In such cases, the scoring system will not apply.

Access

This item applies only to completely remote communities. It is not applicable to areas such as St. Anthony which is serviced by land, air, and sea transportation. The sites are also interconnected by road. A new scoring system was developed for this particular case. (Refer to Section 3.2.7).

Social Impacts

Based on the relative weight assigned in the point system in this assessment, social impacts appear to be overemphasized.

If the WECS is being installed by a utility to replace diesel fuel consumption, then whether or not the interest in the community is high, is of no consequence. There are overall economic benefits associated with the installation in the form of savings to the utility or in energy cost reductions to the community. There will most likely be job creation in the community during construction, regardless of how it is administered.

Acquisition

Under this item, the scoring of points for conditions (a) and (b) are applicable, however, condition (c) is not. If the site is privately owned and cost of acquisition is not economically feasible, then there is no point in continuing with the evaluation. At this point, the evaluation for that site should be discontinued and an alternative one investigated. Acquisition should be evaluated immediately after the windfield item, in the event that condition (c) is encountered. This would eliminate unnecessary data gathering early in the evaluation.

Connection Distance

The arrangement for assessing points under this item for constructing new transmission lines to connect the WECS into the existing grid appears acceptable. However, the nearest point of connection must be examined in the event that it is a single phase line.

It is more advantageous to generate electricity in three phase to supply a portion of a grid which is also in three phase. However, this is not always possible. If the grid is entirely single phase, then the only option open is to feed single phase current into the system. If the grid consists of both single and three phase components, and the nearest point on the grid is not three phase, two options are available.

First, the single phase line could be upgraded to three phase, and thus the WECS could generate electricity in three phase. Unfortunately, the cost of upgrading over a long distance is often prohibitive. In this case, electrical generation will be forced to be in single phase.

The load inbalance of single phase generation will then have to be investigated and compensated for by offsetting single phase takeoff.

Surface Roughness and Environmental Impacts

Two (2) minor items that have not been examined in the Assessment Methodology are surface roughness and environmental impacts. Surface roughness causes turbulence which is not desired for a WECS site. More consideration should be given to smooth barren areas than to jagged rock or forested areas.

Environmental impacts may appear slight with a WECS, but at least two exist. First, it is not desirable to situate a wind turbine in a large bird population, or in line of a migration path. Second, a noisy WECS should not be installed in breeding areas. Objections to such sites can be expected from environmental agencies.

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APPENDIX 1

ASSESSMENT METHODOLOGY

The assessment methodology was developed by ShawMont Newfoundland in the course of a study, "Wind Energy Conversion System, South Coast Region of Newfoundland" done for Newfoundland and Labrador Hydro, also with a contribution from the Remote Community Demonstration Program of Energy, Mines and Resources Canada.

METHODOLOGY

1 Definition of the Region of Interest

Group together those communities that you wish to consider for further study. These communities should appear (best guess) to experience similar meteorological conditions within the same geographic area. This is the Region of Interest.

2 Wind Climate Evaluation

Prior to the assessement of any other parameters, the ability of the windfield to support a WECS must be evaluated. The principal source of wind data is the Atmospheric Environment Service (Appendix E Reference #1).

"Is there any Atmospheric Environment Service (AES) weather data recording stations or provincially operated stations in or close to the Region of Interest?".

Using the locator map (Figure 1) identify AES stations that would appear to represent the windfield of the Region of Interest.

If there are no weather stations but the Region of Interest is coastal, weather data may be available from AES through their Marine Statistics Program. (Appendix A). Marine statistics (MAST) data available from AES is based on ship board observations in the area of interest for the past 20 years or so. The main problem with this data is that the smaller the area one selects the smaller the data set. In the case of the coastal communities the small areas selected, in order to get more site specific data, usually results in less then reliable results. In the area selected there were only 343 weather reports which is too few to generate meaningful results. The MAST data therefore can only be used as a regional assessment tool to compliment the land based data.

"Is there Sufficient Wind Resource ?"

Obviously, the basic question! Consult the tables in Appendix A, and identify the following relevant information:

- prevailing wind direction
- average annual wind speed by direction and frequency of occurrence.
- gusting events by speed and direction.

2 Wind Climate Evaluation (Cont'd)

The average annual wind speed of 12 mph (20 kph) is suggested to be the minimum speed acceptable for effective performance for the type of WECS targeted for remote community applications (20 - 40 kw). (Larger machines (100 kw up to 2 MW) are made for those communities which have a very large demand. Some of these machines however, are still under development or have been untested). If there are data from more than one site the data should be plotted to identify any inconsistencies.

The annual average wind speed of 12 mph at hub height (equator) is an arbitrary figure and may be adjusted depending on the type of WECS to be used.

"Is the Wind Climate fairly Consistent throughout the region?"

Develop wind roses for the AES sites and those areas indicated by co-ordinates for the collection of Marine Statistics data (Figure 2 is an example of how the wind resource can be mapped for purposes of comparison). If the data are fairly consistent for all sites, a general assumption can be made that the windfield is consistent throughout the region. However, as is the case in the example (Figure 2), there may be anomolies. These anomolies must be identified and explained. For example - Is the AES station in a totally different wind climate? Is there a major topographical barrier influencing the data? etc.

"Will these Inconsistencies (Data Anomolies) preclude some communities from further consideration?"

It is now necessary to make a qualitative judgement as to whether these anomolies indicate that some of the communities do not have the necessary windfield. If so, disqualify that community. At this point, the regional wind climate evaluation is complete.

3 Collection of Secondary Source Data

To carry out a detailed evaluation of each community/site it is necessary to collect as much relevant information as possible on each community in the region from the following sources:

3 Collection of Secondary Source Data (Cont'd)

Agency	Information	Location & Contact (Appendix E)
1. Atmospheric Environment Service Environment Canada	Wind & Ice Data	Reference 1 & 2a, 2b

The amount of data available from AES locally is extremely limited. AES in Downsview has access to all the statistics available and can carry out computer analyses on specific parameters. Their turnaround time for this service is approximately 2 weeks and the fee charged is very reasonable.

2.	Newfoundland and Labrador Dept. of Forest Resources & Lands	Topographic Mapping & Aerial Photographs	Reference 3

The mapping division of this department will provide 1:50,000 scale maps of any area in the province on request. Larger scale mapping is available only for the Avalon Peninsula and the coverage for the orthophoto mapping is extremely limited. The turnaround time of aerial photographs is approximately 3-4 weeks.

3.	Newfoundland and Labrador Dept. of Mines & Energy	Surficial Geology	Reference 4

Data available on request.

4.	Energy, Mines Resources Canada	- Overview Study - Remote Community Demonstration Program Criteria	Reference 5

Data available on request for Communities in the region of interest. The Overview Study has carried out the basic social and cultural research.

5.	Dept. of Communications	Communication Systems Information	Reference 6
6.	Memorial University	Background Literature	Reference 7

3 Collection of Secondary Source Data (Cont'd)

7. Local Community District Authorities — Local Input

4 Terrain Evaluation

4.1 Background

The topography in a given area should be viewed with the purpose of estimating the wind flow patterns around the terrain, pinpointing areas of possible turbulence and selecting potential locations for wind measurement preferably away from this turbulence. Topography in any given area can be classified into either flat or non flat terrain (Wegley, 1980), as follows:.

.1 Flat Terrain

No terrain is really flat as there are always small irregularities or large gently sloping features, however, with respect to small scale terrain irregularities, terrain may be considered flat if:

-- elevation differences between the wind turbine site and the surrounding terrain are not greater than 50 m within 10 km of the site
-- no hill has an aspect ratio (height divided by diameter) greater than 1/50 within 5 km upstream and 1 km downstream of the site (Frost, 1981)

These parameters may be determined by examining a 1:50,000 topographic map and aerial photographs. In Newfoundland, the occurence of flat terrain is usually restricted to areas such as barrens, large bogs and, occasionally, coastal flats.

.2 Non Flat Terrain

Non Flat terrain is divided into two groups: small scale and large scale terrain.

For the purposes of WECS siting, the difference between small and large scale terrain is determined by how much effect a particular geographic feature or area has on the planetary boundary layer (PBL). The PBL is, roughly, the first kilometer of atmosphere where the direct effect of turbulent transfer of heat and momentum is observable. Small scale features are those which do not significantly alter the wind flow in the PBL.

4.1 Background (Cont'd)

.2 Non Flat Terrain (Cont'd)

A large scale feature is one that extends through a significant portion of the PBL or even above the height of the PBL and significantly modifies the structure of the entire boundary layer resulting in wind turbulence which must be avoided when siting a WECS.

As it is not possible to determine the height of the PBL without expensive monitoring and testing procedures small scale terrain will be defined as any feature which is less than 100 m in height while large scale is any feature greater than 100 m in height.

These heights are guidelines only and it should be noted that unacceptable turbulence may be associated with small scale features as well as with large.

As with flat terrain, analysis of non flat terrain is carried out using topographic maps and aerial photographs.

Some geographic features accent the wind rather than impede it and should be looked for when carrying out the preliminary site evaluations. Some of these features are:

-- relatively flat smooth areas
-- small ridges normal to the prevailing wind
-- small cliffs facing upwind - location of the WECS above a concave section is best
-- small hills with slopes in the vicinity of 30% (can be determined from cross sections)
-- ridge and mountain upper slopes - these have stronger winds and less diurnal variation than a valley.

Some areas which should be avoided when siting a WECS are as follows:

-- in the lee or at the base of hills
-- small valleys
-- small basins
-- small gaps between larger features
-- flat topped large ridges and mountains - these may produce wind shear and flow separation.

4.1 Background (Cont'd)

.2 Non Flat Terrain (Cont'd)

For a good concensus of methods for terrain analysis, Chapters 3 and 4 of the Siting Handbook for Small Wind Energy Conversion Systems on siting in flat or over non-flat terrain have been included for reference in Appendix B.

4.2 Aerial Photo Interpretation Analysis of Sites

Using the background data from 2.4.1, the data in Appendix B, the aerial photographs and topographic maps, evaluate each community as to potential WECS sites.

"Does the topography obviously preclude some communities?"

This aspect is intended to be a cursory look and is limited to an assessment of whether or not the local terrain is totally inaccessible.

"Can potential WECS sites be identified within close proximity (0.3 km to 2 km) of the community?"

Increasing distance from the existing distribution system will directly affect the economic viability of the installation. Having initially identified potential sites, the following method should be employed:

.1 Contour Sketch Maps

Using copies of the aerial photographs transpose the contour lines from the 1:50,000 topo sheets. This serves a similar purpose to the orthophoto map and will aid in the interpretation of the features. It will also aid site identification in the field visit.

.2 Cross Sections

Construct cross sections of the likely sites in the direction of the prevailing winds. This method enables the analyst to get a good appreciation of the vertical characteristics of the area around the communities (Figure 3 gives an example of a typical cross section) and allows calculation of the slope at the site.

5 Preparation of Community Questionnaire

Because of the importance of site specific phenomena with respect to a WECS installation, the opinions of local residents are an invaluable guide to the local conditions experienced. Through a questionnaire it is possible to get input on weather conditions, topography, social impacts, etc. Particularly in the remote communties of this Province, people's lives are linked to the weather and they have a good understanding of conditions that influence their livelihood. The success of this questionnaire, like all questionnaires, is, firstly, that it be completed and, secondly, that the respondents understand the questions in the same way.

Ideally, it would be possible to mail several questionnaires to each community to be circulated to responsible and knowledge individuals to fill out and return. In practice this may not be effective and it may therefore be necessary to carry out interviews whilst at site. If site visits are not possible then the adaption of the questionnaire to a telephone format would be an effective way of extracting information. In the final analysis, it will probably be necessary to use mailed questionnaires with telephone follow-up in order to maximize response. The sample questionaire is located in Appendix D.

6 Matrix Evaluation

Table 1 indicates the categories included in the matrix evaluation and the weights applied to each item. The scoring system will allow for one or more WECS site per community.

6.1 Windfield

As previously stated, the windfield for each candidate site will be given a "YES" or "NO" rating. A "YES" designation for any site will indicate that the regional wind regime is believed to be sufficient to power a WEC system. A "NO" on the windfield for any site indicates that the wind regime is not sufficient to drive a WECS and the site will be disqualified. An average annual wind speed of 12 MPH (20 KPH) will be the minimum acceptable for a site to qualify for a WECS installation.

6.2 Topography

Topography is classified as one of the following groups:

-- Flat Terrain
-- Non Flat

6.2 Topography (Cont'd)

Each site at the various communities will be placed in one of the above categories and their location assessed based on the information given in section 2.4. If the site is in a location which is inaccessable or is too distant (greater than 2 km) from the community the topography is scored with a "No" and the site disqualfied. If the site is in a favourable location then it is given "Yes" and subjected to the following scoring scheme.

1. The site is exposed to the wind from all directions and there are no terrain features within 10 km which could create unacceptable wind patterns such as turbulence and wind shear
30 points

2. The site is exposed to wind from all directions but there are higher points of land within 10 km of the site - 20 points

3. The site is exposed to the prevailing wind but blocked by higher features in other directions
10 points

4. The site is located in a potential area of high turbulence 0 points

6.3 Safety

The safety factor in the installation of a WECS machine is one that must be considered. The principal hazards associated with a WECS system are thrown ice or a thrown blade striking a dwelling or person.

Based on the literature search, it is recommended that any WECS site be at least 750 feet from the nearest dwelling. It is futher recommended that if these criteria cannot be met then the site should be disqualified. Safety will be scored with a YES/NO.

6.4 Icing

In areas that experience freezing rain and drizzle, ice accumulations on blades, towers and transmission lines can reduce efficiency and availability and, in severe cases, destroy the wind machine. There are two types of icing: rime ice and glaze ice. Rime ice forms as a result of freezing fog or frost. It is generally less dense than glaze ice and therefore less hazardous. Glaze ice forms as a result of freezing rain which freezes on contact and can accumulate to several inches. Heavy icing caused by freezing rain could cause structural failure in a WECS.

6.4 Icing (Cont'd)

To determine icing potential for a given site, there are three possible sources of information. These are:

-- Data collected by the Atmospheric Environment Service.
-- Information from local residents on historic icing conditions in the community
-- Utility Companies (Reference #89 Appendix E)

Icing data available for AES details icing events on an hourly basis but does not list the degree of accumulation. However, most wind machines have systems by which they can shut down should ice loading become a problem and ice is then only a major problem in two senses, - frequency of occurrence and total weight of ice.

.1 Frequency of Occurrence

Ice data from AES stations and Marine statistics can be obtained from AES Downsview and is compiled by event occurrence only (Figure 4). Neither the ice build up is calculated nor is the duration of the event indicated. However, because most WECS are protected such that the machine will shut down when vibration occurs, the number of events becomes a relevant statistic. If a worst case scenario of machine shut down on each hourly occurrence of the freezing precipitation is calculated then it is possible to approximate the number of days per year lost due to icing. Also to be considered is the fact that ice may persist on a surface after a storm due to the continuation of freezing temperature conditions.

.2 Total Weight of Ice

This is directly related to the worst possible ice storm and the survival characteristics of the wind machine and tower. This worst case scenario will be subjectively evaluated in discussion with local residents as to their recollection of major storms.

To evaluate the candidate sites a point scoring system will be used as follows:

(a) Less than 200 events of freezing precipitation per year - 10 points

(b) 200 - 500 events of freezing precipitation per year - 5 points

(c) over 500 events of freezing precipitation per year - 0 points

6.5 Soils and Geology

To evaluate the difficulty of installation and the materials and equipment required to erect a WECS, it is necessary to know the geology of the sites. The geology may be obtained by examining aerial photographs and geological maps. There are three basic types of surface material which are of interest when erecting a WECS in Newfoundland. These are: bedrock, till and bog.

Bedrock is the most favourable medium as it requires limited equipment and no major foundation work to erect the tower. To erect a tower on till would require digging equipment and foundation. The third type of surface material which may be encountered is bog. This is extremely difficult to work on unless it is very shallow (less than 1 metre) and should be avoided.

In evaluating the soils and geology portion of the matrix, the following scoring will be used:

(a)	Exposed or thinly covered bedrock	- 10 points
(b)	Till	- 5 points
(c)	Bog	- 0 points

6.6 Equipment and Skill Availability

The availability of equipment and skill in remote communities is not considered to be of prime importance in the site selection process. The erection of a WECS is a specialized job and may require personnel familiar with this type of installation. In most cases, heavy equipment necessary to the installation, if not available at the site, could be brought in either by road or boat.

The scoring scheme for equipment and skill availability in the matrix are as follows:

(a)	All necessary equipment and skill available at site	- 10 points
(b)	Some equipment and skill available at site	- 05 points
(c)	No equipment available	- 00 points

6.7 Access

Accessibility to the community and the specific site is very important in site selection as it can impact dramatically on the economic feasibility of the project.

6.7 Access (Cont'd)

Accessibility to the community is necessary to deliver the WECS and related equipment. It is necessary to know what type of transportation links (sea, road, air) services each community. This information can be obtained by consulting a map or direct inquiry with the community by mail or telephone. This information will aid in determining the economics of installation of the WECS for a given site.

Information respecting specific site access is required to determine such details as the length of access road required and ownership of access land.

Matrix scoring for accessibility will be as follows:

(a) Community accessible by road, and boat with site accessible by road - 25 points

(b) Community accessible by boat and road with site requiring construction or upgrading of access road - 15 points

(c) Community accessible by boat with site accessible by road - 20 points

(d) Community accessible by boat with site requiring construction or upgrading of access road - 10 points

(e) Community assessible by boat with site requiring extensive construction of access road. - 05 points

(f) Community accessible by boat only and construction of access road to site not feasible requiring helicopter for equipment transport. - 00 points

6.8 Social Impacts

The social impacts associated with the installation of a WECS system are expected to be minimal yet they bear important consideration. The most immediate positive impact will be the short term employment for some local residents during construction of the access road, if required, and possibly the erection of the machine(s).

The primary method of social impacts evaluation will be the a questionnaire polling residents for their opinions, as discussed in 2.5.

6.8 Social Impacts (Cont'd)

Scoring for this category with be as follows:

(a) Positive impacts such as job creation; very positive attitude shown by the community towards the system. - 10 points

(b) Social impact minimal or none, yet interest in community is high. - 05 points

(c) Social impact minimal with very little interest shown on the part of the community. - 00 points

6.9 Acquisition

When a potential WECS site is considered, the ownership of the land and whether it is available for purchase or lease must be taken into account. If the potential site is privately owned, the cost of acquiring the land may be prohibitive. If the land is publicly owned, then permission must be obtained to purchase or lease the land from the government in charge. In Newfoundland, this is not usually a problem unless the land is within Provincial or National Park boundaries.

Scoring for acqusition within the matrix is as follows:

(a) The site is on crown land which is readily available for lease or purchase at a minimum cost. - 10 points

(b) The site is on restricted government property where acquisition will be difficult or on privately owned land which involves purchase negotiation. - 05 points

(c) The site is privately owned and cost of acquisition is not economically feasible. - 00 points

6.10 Demonstration Visibility

For the purposes of this project, site selection with regards to demonstration visibility is being considered in the evaluation process.

Scoring for the demonstration visibility will be as follows:

(a) WECS located in population centre of more than 2,000 people - 05 points

6.10 Demonstration Visibility (Cont'd)

(b) WECS located in population centre of 1,000 to 2,000 people - 03 points

(c) WECS located in population centre of less than 1,000 people. - 00 points

6.11 Electro Magnetic Interference (EMI)

As WECS machines are a potential source of electro magnetic interference, it is very important that the site be selected so as not to interfere with television and microwave reception. This situation can be avoided by selecting a site out of the direct line of transmission. The best method for determining transmission direction is to have questionnaire respondents note the direction of TV antennas on houses in their areas and the strength of their TV signal. A map indicating the location of TV transmitters in Newfoundland and Labrador is located in Appendix C.

Scoring for EMI will be as follows:

1. Site completely removed from line of transmission 15 points.

2. Site close to line of transmission but potential interference unlikely 10 points.

3. Site in direct line of transmission 0 points

6.12 Connection Distance

The location of the WECS site will dictate the length of transmission line that must be run to connect the WECS to the existing distribution lines. A long connection line will negatively effect the economics of the site especially if the terrain is very rugged, as it is in most areas. Evaluation of each site for connection distance is as follows:

1.	Less than 0.2 km	20 points
2.	0.2 to 0.4 km	15 points
3.	0.4 to 0.6 km	10 points
4.	0.6 to 0.8 km	5 points
5.	0.8 to 1 km	0 points

Connection distances greater than one km will have to be separately and and very critically reviewed with respect to the specific system being considered. A large WECS system may be able to accomodate the cost of a longer tranmission line, whereas this would probably be uneconomical for a small system.

6.13 Minimum System Demand

The largest WECS that can be safely operated with existing diesel generator systems is a function of the minimum system load and the size of the on-line diesel generator(s) normally operated to service this load. (If the minimum load is not on record or known, the plant operating personnel will be required to produce a series of daily load profiles). Generally the higher the minimum load, the greater the potential for WECS. the following weighting scheme will apply for minimum load evaluation in each community:.

1.	Minimum load above 60 kW	15 pts
2.	Minimum load between 30 - 60 kW	10 pts
3.	Minimum load between 20 - 30 kW	05 pts
4.	Minimum load less than 20 kW	0 pts

If the minimum system load is so low, say less than 10 kW, than it is virtually impossible to adequately penetrate it with any of the commercially available, proven WECS, then the decision will have to be made to abandon this community, regardless of how well it scores on the other categories.

6.14 Fuel Costs

Since economic feasibility will usually be the ultimate rationale in the installation of a WECS on a given site, economics must be sufficiently considered when initially evaluating a site for a potential WECS installation. This is already done indirectly by weighting such criteria as access, skills and equipment, etc., and the final economic input at the preliminary assessment stage will involve factoring in the costs of the diesel fuel consumed at each site.

The unit fuel cost for each community will be used as a biasing tool to: decide between sites of similar weighting scores, assist in determining whether a community with a relatively low score may have some potential on the basis of cost savings, and provide a feel for the expected economic range of an installation. The higher the cost of fuel the more economical the installation will be and, consequently, the more attractive the site will be for a WECS installation.

This cost parameter will not be weighted but, rather, will be applied as necessary as a bias after the sites have been otherwise evaluated.

7 Community Visits

If the desk study indicates some potential WECS sites they must be screened through site visits. During these visits the analyst can use the oportunity to collect the questionnaires and interview local residents regarding local wind conditions. As well, the surrounding terrain will be examined and any terrain features or obstacles that could affect wind characteristics at the site will be noted. Factors that affect the cost of developing the site such as access road construction, etc. will also be noted.

Valuable information on wind characteristics at the site can be obtained by examining various biological, cultural and social indicators and by measuring the wind profile with a tethered aerodynamic lifting kite anamometer (TALA). Profile measurements made with a TALA Kite during site visits could be used primarily to identify obvious potential hazards, such as flow separation and turbulence and high wind shear that accompany them.

An additional method of wind climate assessment is to have a thorough knowledge of the sites where weather stations presently operate. These sites can then be compared to potential WECS sites that have similar terrain characteristics. Site discriptions of weather stations are available from AES but it may be advisable to visit the stations for a first hand look.

The following is a check list of steps to aid in field data collection.

.1 Visit Primary Contact - Having arranged prior to departure your approximate time of arrival, be sure to set a good rapport with this individual.

.2 Collect Questionnaire - If questionnaire was mailed, personally visit the respondents and generally discuss their opinions. An opportunity may present itself to interview more residents either formally or informally.

.3 Identify Terrain Problems - based on data collected in-house, confirm major barriers to windfield.

.4 Locate Potential Sites - note access problems to site, take panoramic campsite photographs of potential sites. Carry out kite observations when the wind is at its strongest for that day, usually mid-afternoon.

.5 Note Biological and Cultural Indicators of Wind Climate - reaffirm the opinions of local residents by checking for vegetation and buildings for wind and ice damage.

7 Community Visits (Cont'd)

.6 Verify local geology - If visual inspection is not sufficient, then a backhoe, if available, may have to be hired to dig test pits.

.7 Meet with operator of diesel plant - verify existing and collect any new data respecting load and generation; obtain an understanding of the normal philosphy of operation of the plant.

.8 General - confirm accessibility of transportation links for construction machinery and the offloading of WECS components.

In essence, the matrix evaluation is being carried out again and compared to the original desk study.

Equipment required for community visits will include:

-- Clipboard
-- Extra Questionnaires
-- Proof of Identify (EMR/Hydro letter)
-- Camping Gear
-- Binoculars
-- Camera
-- Maps
-- Compass
-- TALA Kite (if available; if not use regular kit to attempt to get some idea of wind shear and turbulence)

8 Final Assessment

Following the site visit, the collected data is reassessed, based on the information obtained from the questionnaires and on-site evaluations and measurements, and re-entered into the matrix for a final evaluation.

EVALUATION MATRIX

Weighting Categories		Wind Field	Topo-graphy	Safety	Icing	Soils & Geology	Skill & Equipment	Access	Social Impacts	Acquisition	Demo Visibility	EMI*	Connection Distance	Min. Demand	Total
Max Weight		Yes/No/	Yes/No/25	Yes/No	10	10	10	25	10	10	5	15	20	10	155
Community	Site No														

* EMI - Electromagnetic Interference

APPENDIX 2

WIND SPEED EXCEEDENCE AND DISTRIBUTION GRAPHS BETWEEN CAPE NORMAN AND ST. ANTHONY STATIONS

Figure 1

Monthly Wind Speed Exceedences

Cape Norman, Nfld., May 17 to July 31, 1982

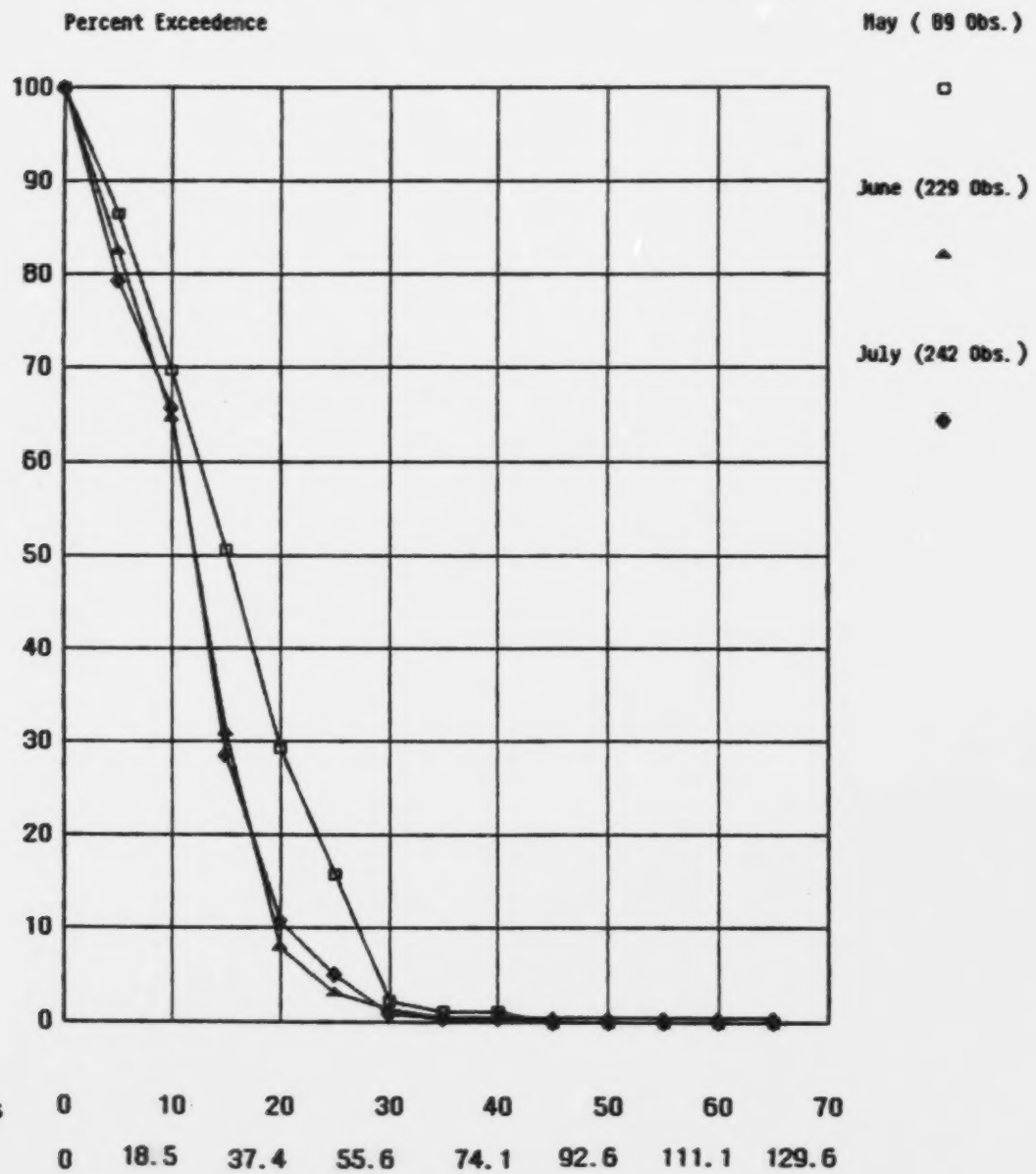


Figure 2

May to July Combined Wind Speed Exceedences

St. Anthony #8403400 (1953-65), #8403401 (1970-84) and #8403402 (1966-84)

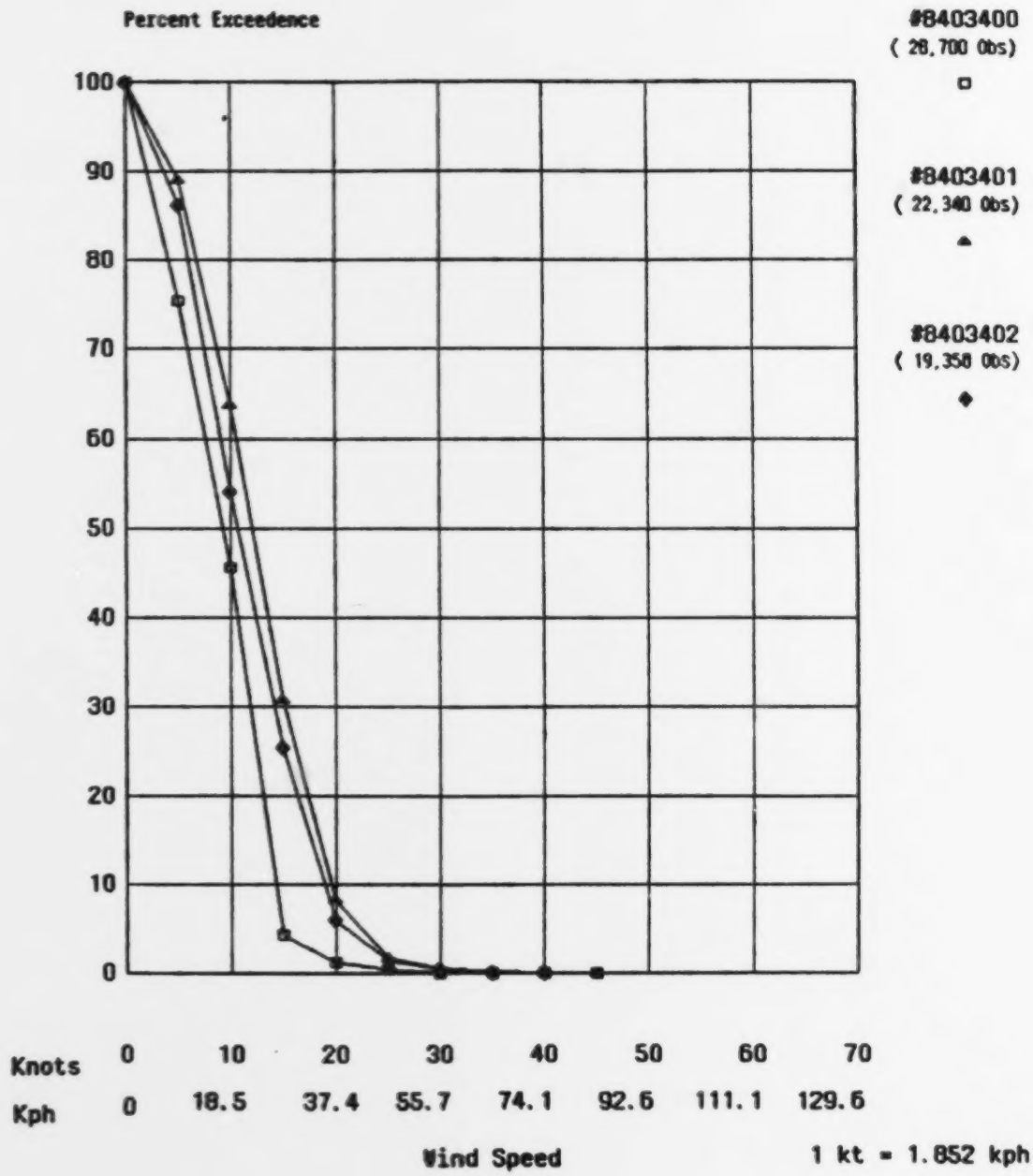


Fig.

Figure 3

May to July Wind Speed Exceedences

St. Anthony #8403400, 1953-65

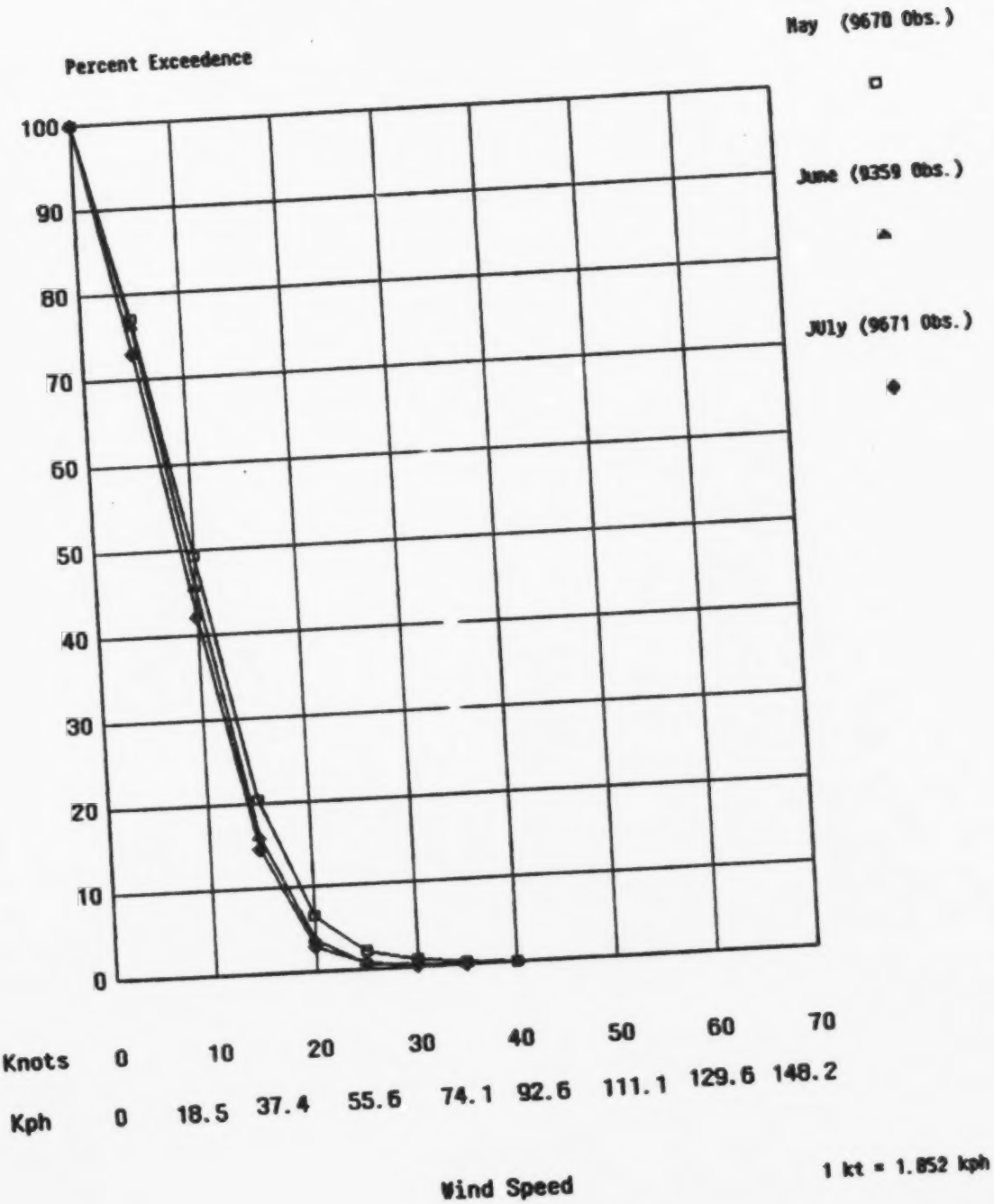


Figure 4

May to July Wind Speed Exceedences

St. Anthony #8403401, 1970-84

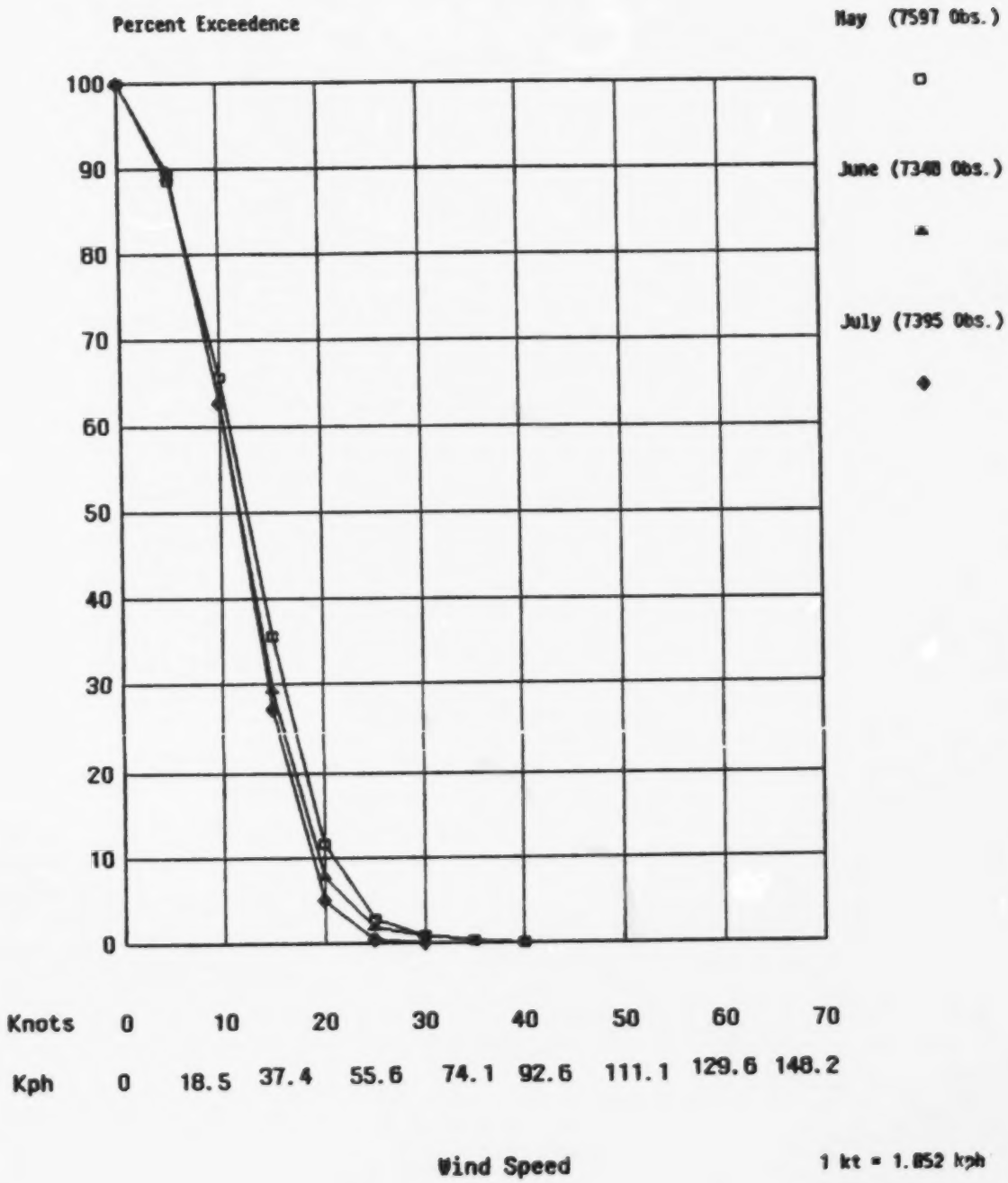
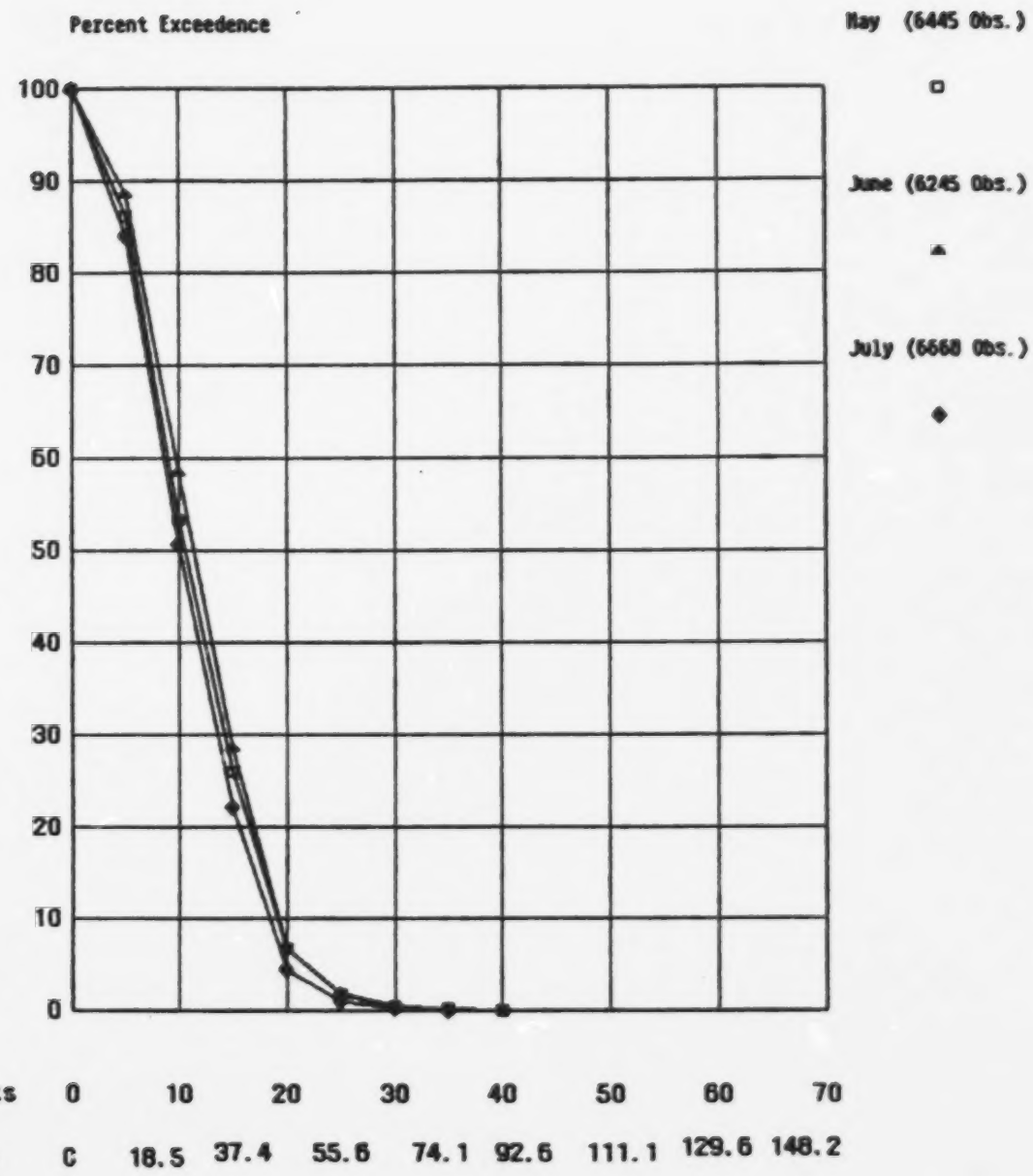


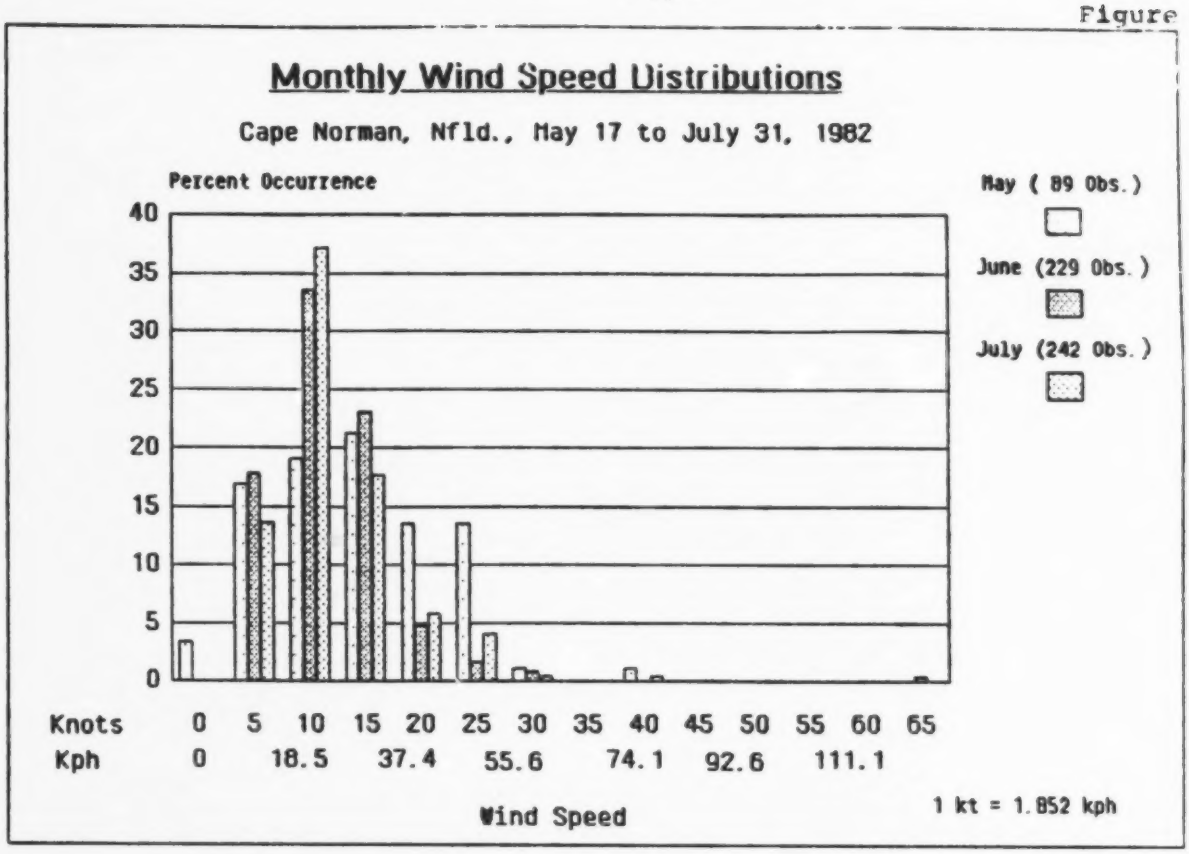
Figure 5

May to July Wind Speed Exceedences

St. Anthony #8403402, 1966-84



Figure


Monthly Wind Speed Distributions
Cape Norman, Nfld., May 17 to July 31, 1982
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (89 Obs.)
June (229 Obs.)
July (242 Obs.)
Knots 0 5 10 15 20 25 30 35 40 45 50 55 60 65
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1
Wind Speed
1 kt = 1.852 kph

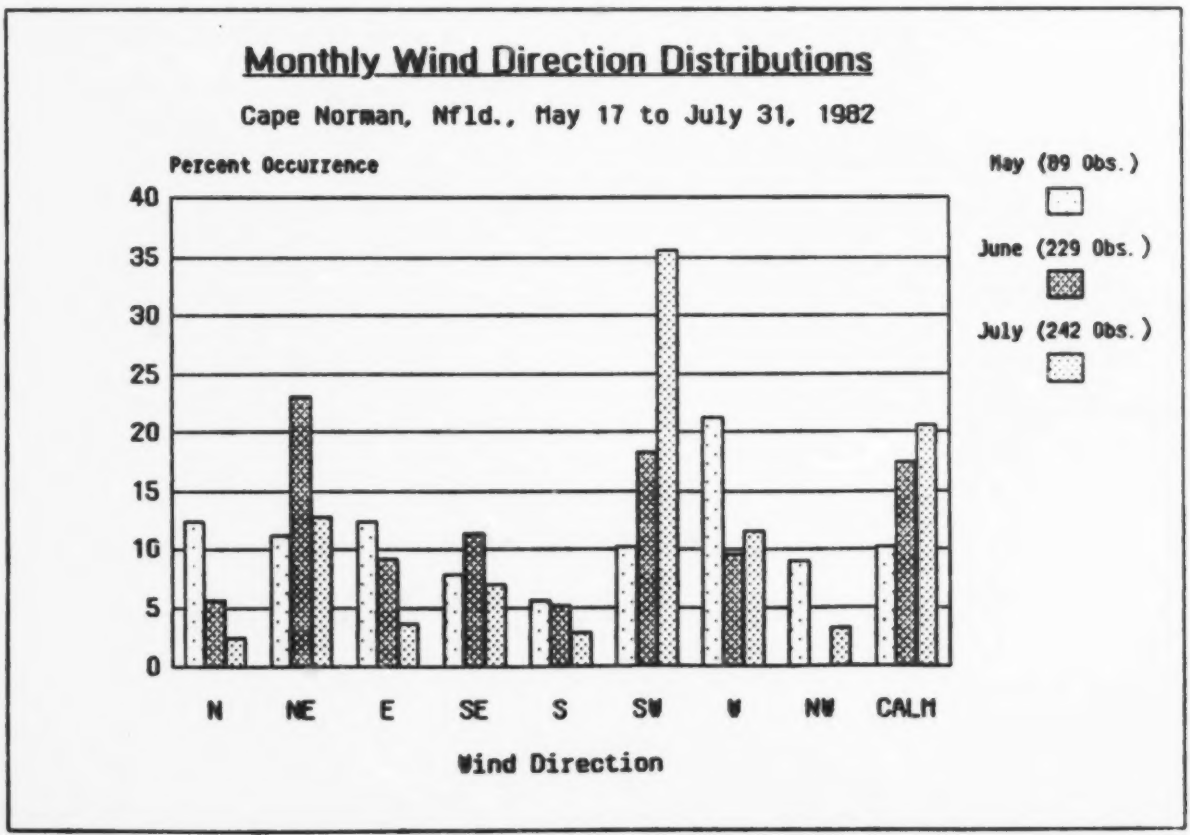
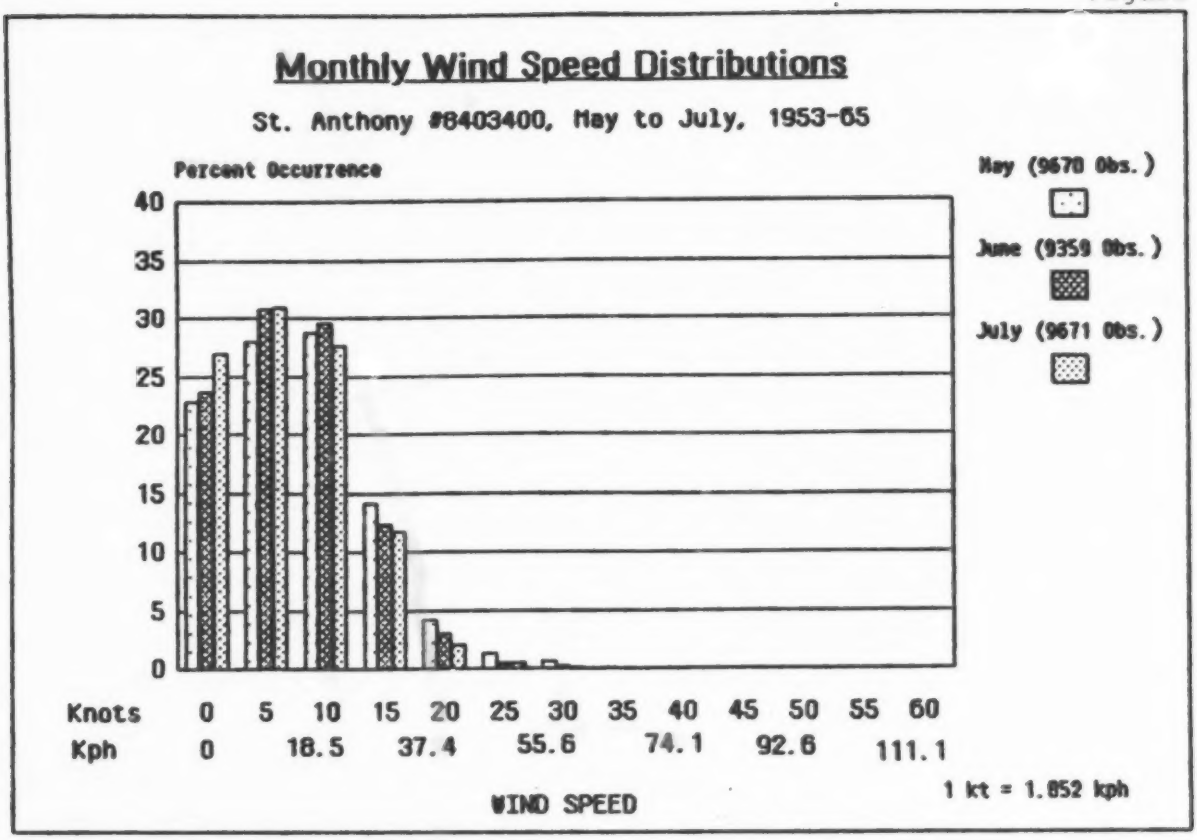

Monthly Wind Direction Distributions
Cape Norman, Nfld., May 17 to July 31, 1982
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (89 Obs.)
June (229 Obs.)
July (242 Obs.)
N NE E SE S SW W NW CALM
Wind Direction

Figure 7


Monthly Wind Speed Distributions
St. Anthony #8403400, May to July, 1953-65
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (9670 Obs.)
June (9359 Obs.)
July (9671 Obs.)
Knots 0 5 10 15 20 25 30 35 40 45 50 55 60
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1
WIND SPEED
1 kt = 1.852 kph

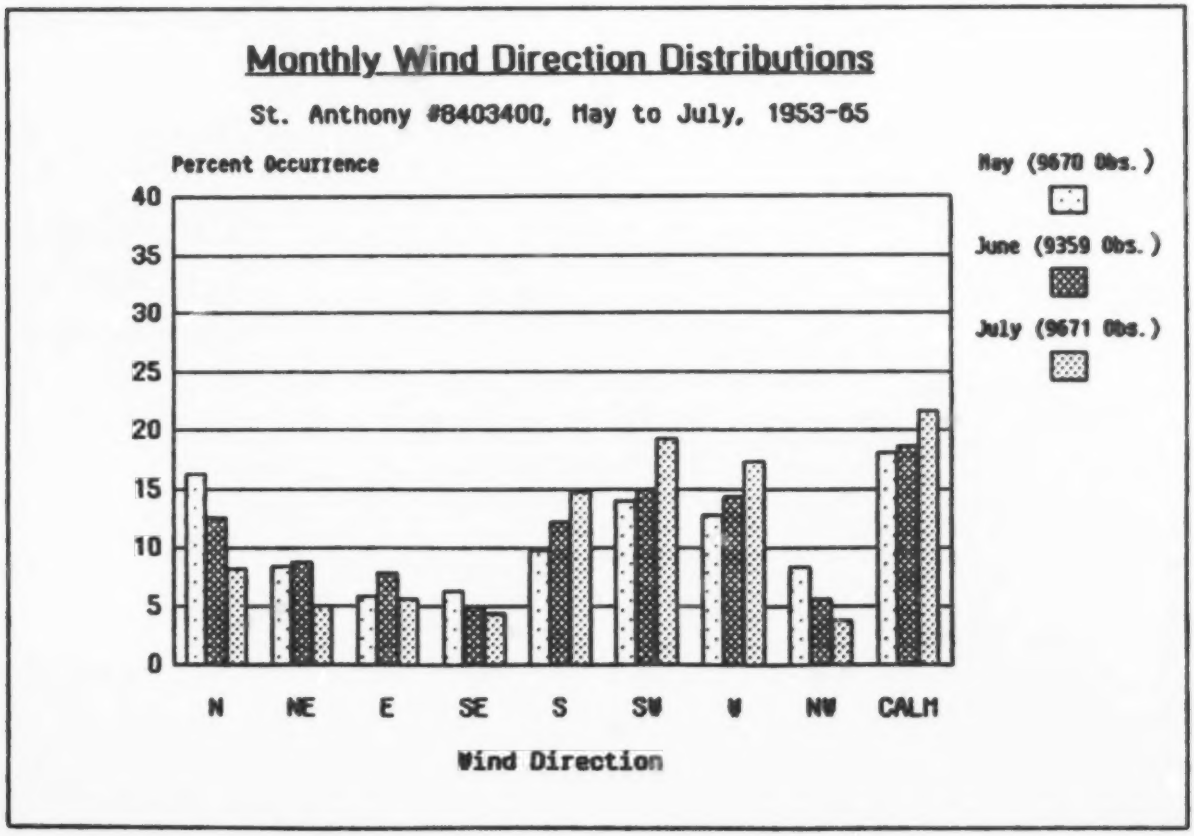
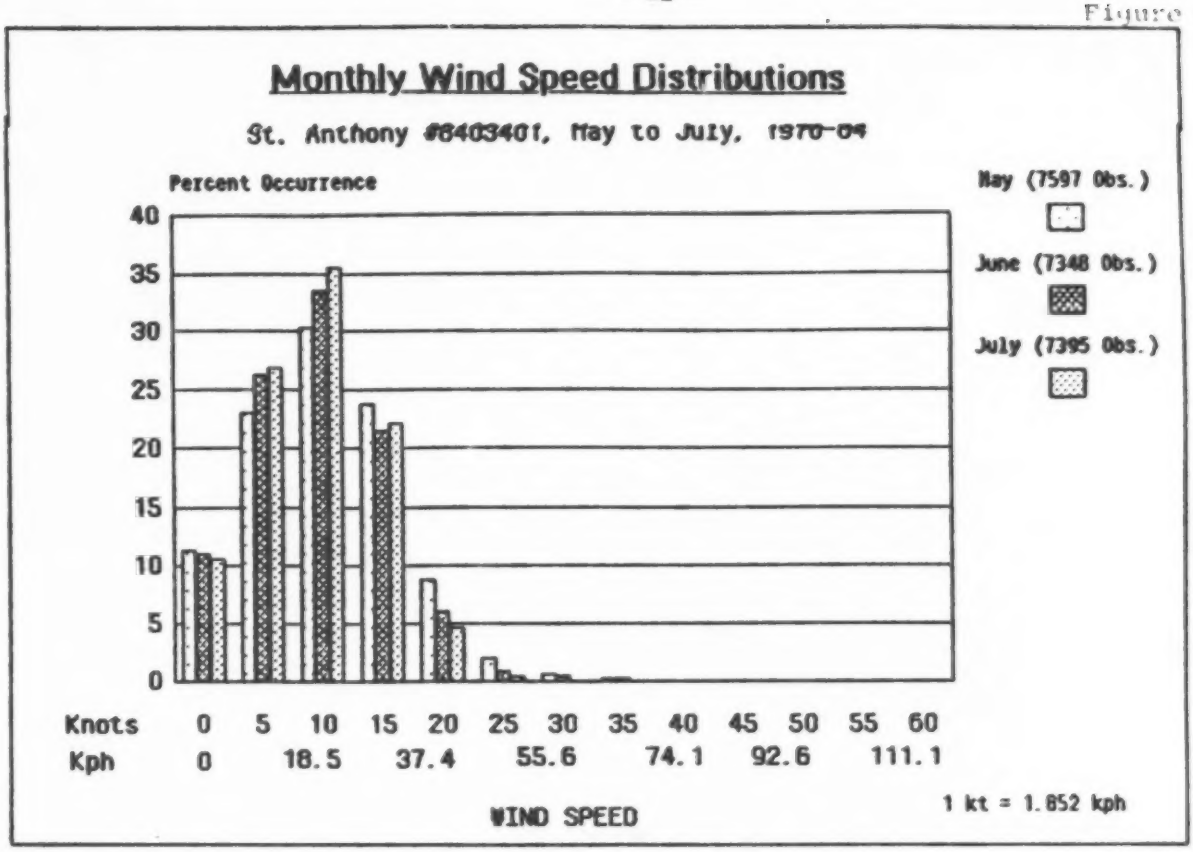

Monthly Wind Direction Distributions
St. Anthony #8403400, May to July, 1953-65
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (9670 Obs.)
June (9359 Obs.)
July (9671 Obs.)
N NE E SE S SW W NW CALM
Wind Direction

Figure 8


Monthly Wind Speed Distributions
St. Anthony #8403401, May to July, 1970-84
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (7597 Obs.)
June (7348 Obs.)
July (7395 Obs.)
Knots 0 5 10 15 20 25 30 35 40 45 50 55 60
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1
WIND SPEED
1 kt = 1.852 kph

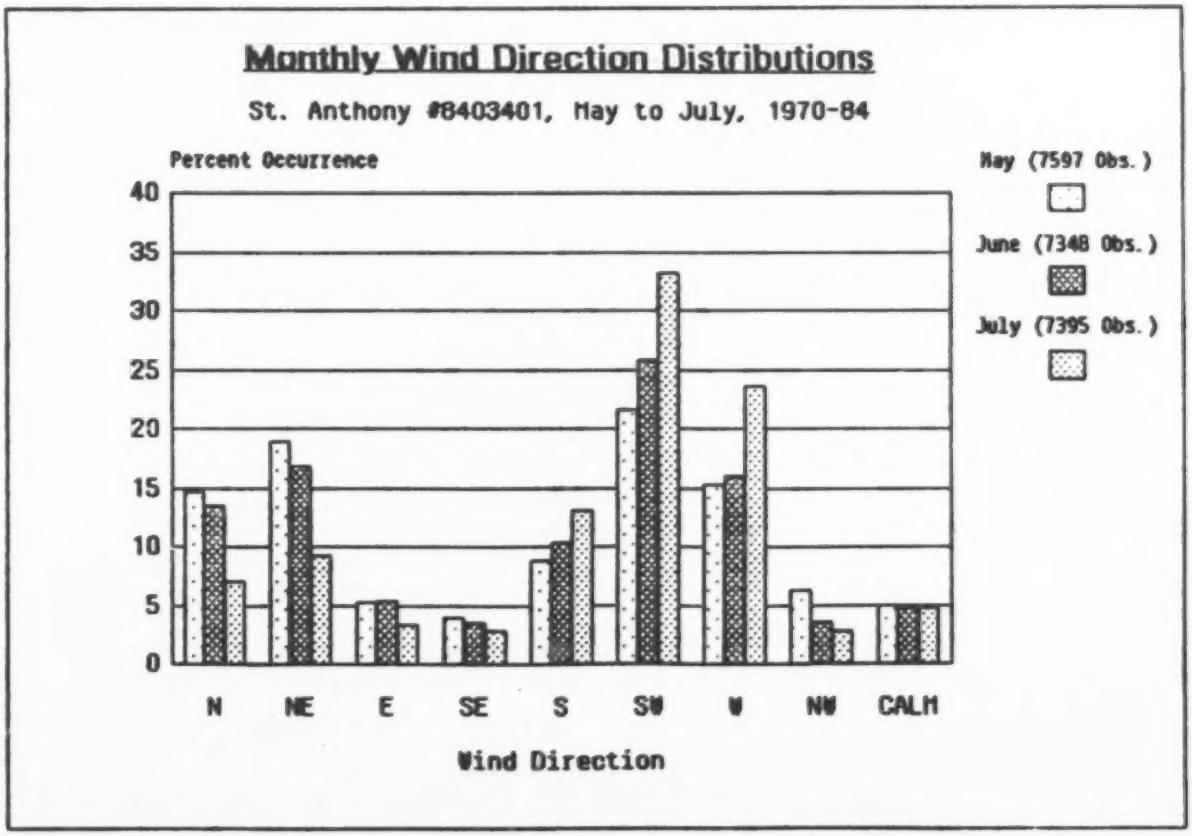
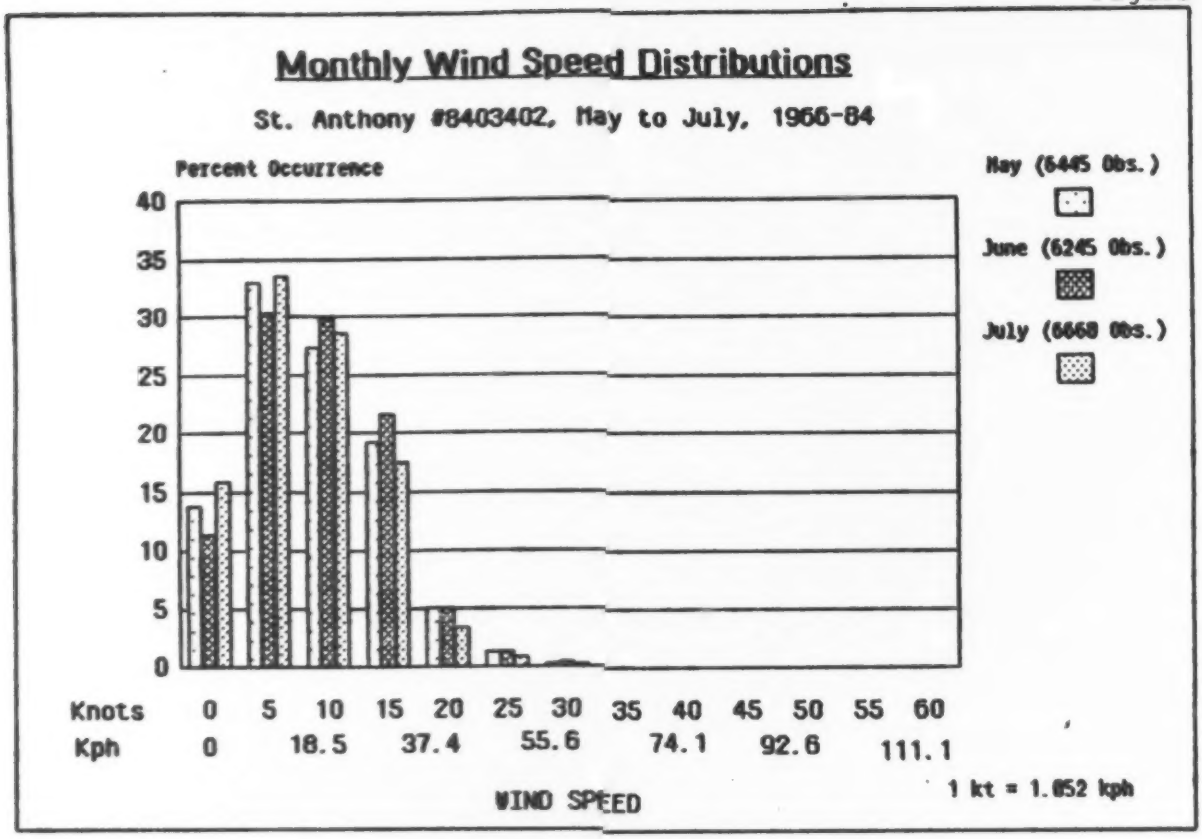

Monthly Wind Direction Distributions
St. Anthony #8403401, May to July, 1970-84
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (7597 Obs.)
June (7348 Obs.)
July (7395 Obs.)
N NE E SE S SW W NW CALM
Wind Direction

Figure 9


Monthly Wind Speed Distributions
St. Anthony #8403402, May to July, 1966-84
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (6445 Obs.)
June (6245 Obs.)
July (6668 Obs.)
Knots 0 5 10 15 20 25 30 35 40 45 50 55 60
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1
WIND SPEED
1 kt = 1.852 kph

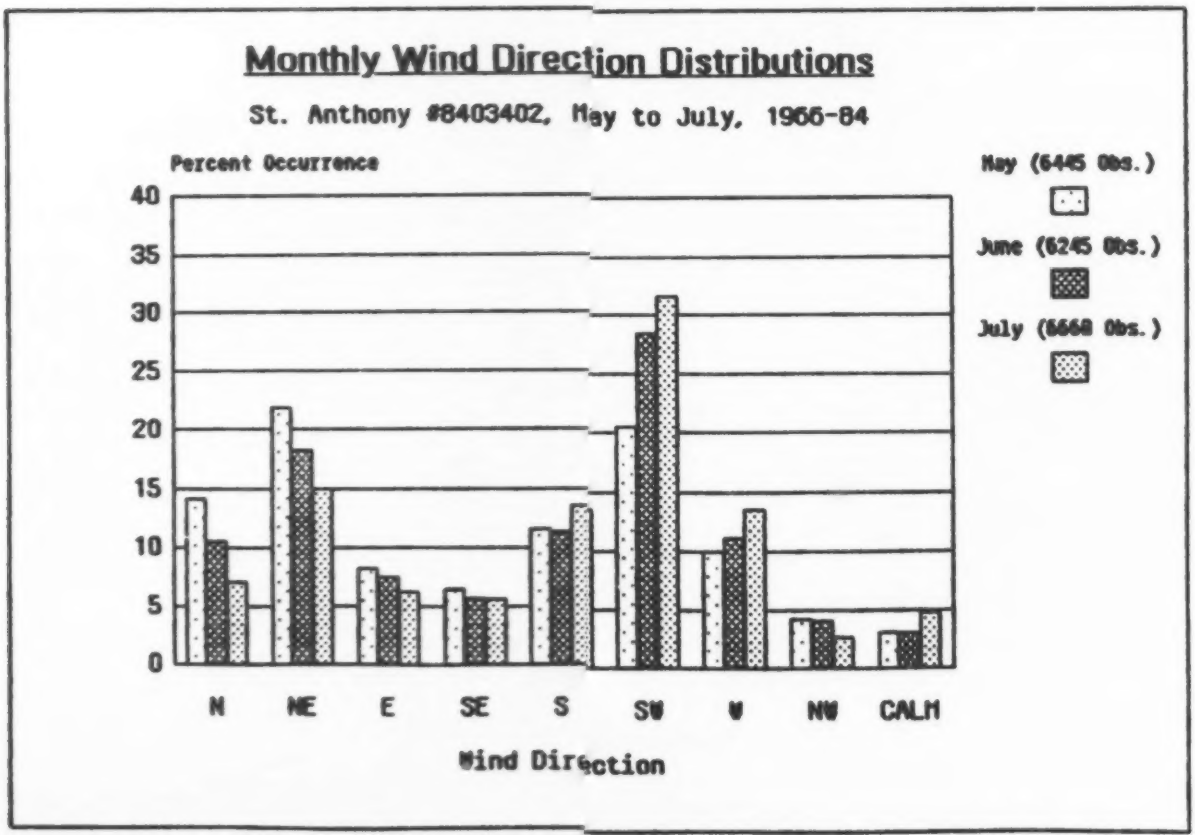
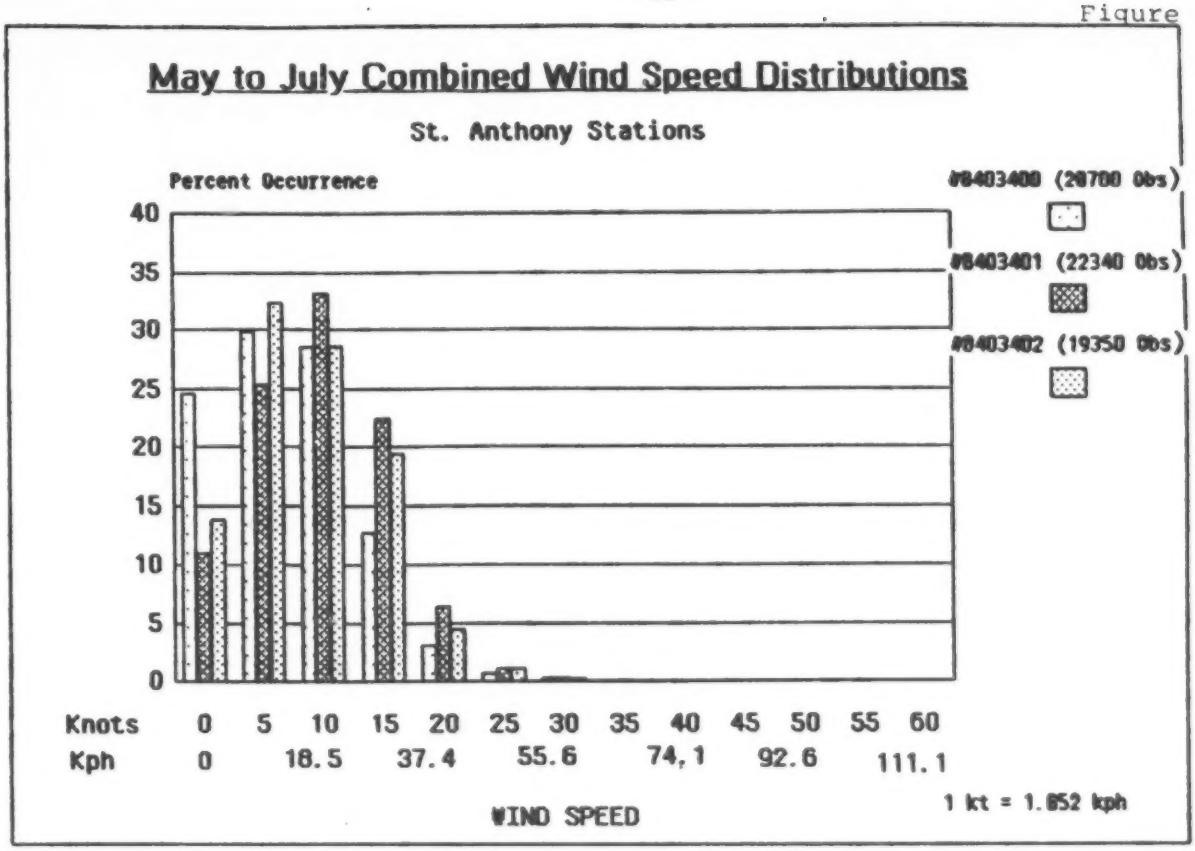
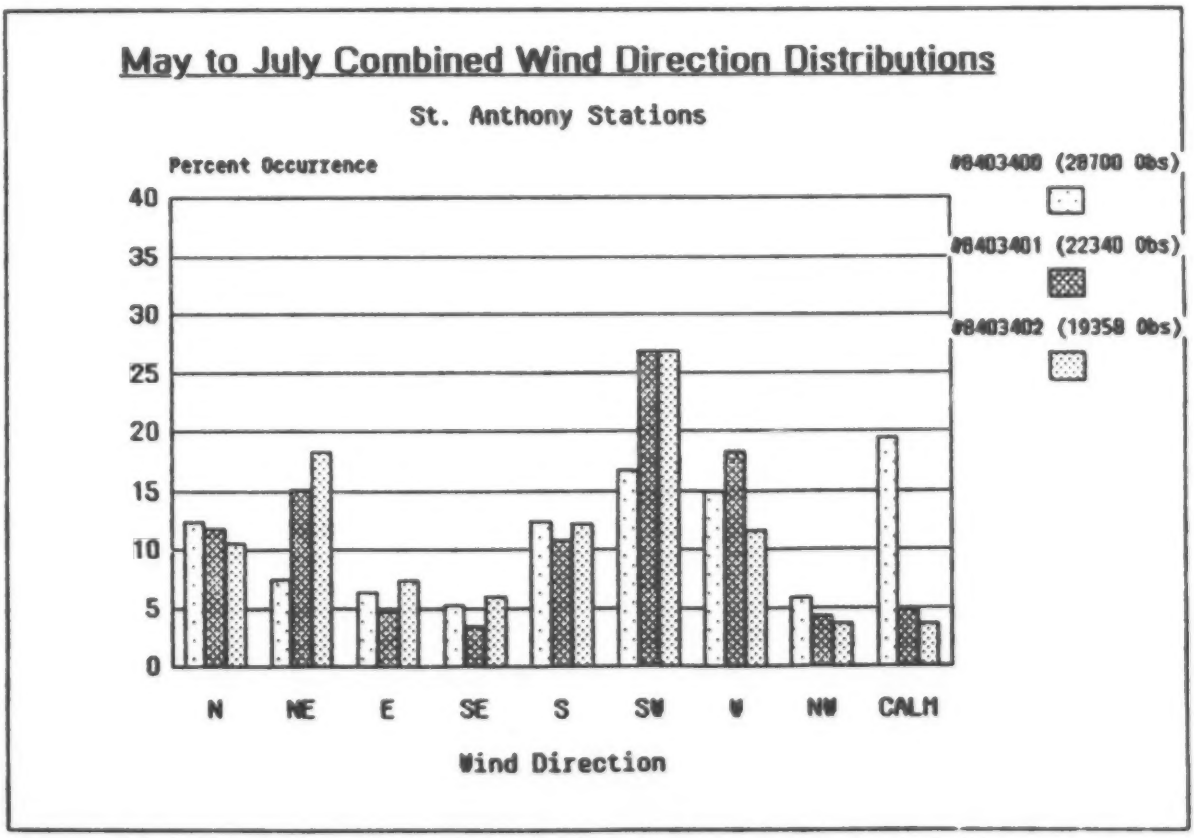

Monthly Wind Direction Distributions
St. Anthony #8403402, May to July, 1966-84
Percent Occurrence
40
35
30
25
20
15
10
5
0
May (6445 Obs.)
June (6245 Obs.)
July (6668 Obs.)
N NE E SE S SW W NW CALM
Wind Direction

Figure 10

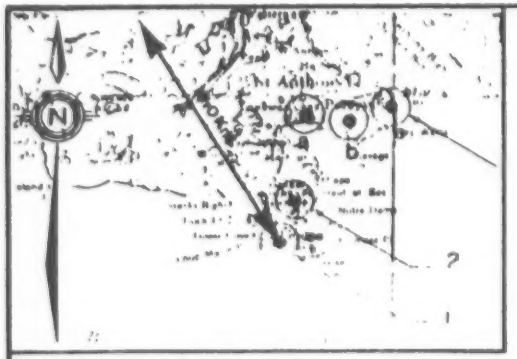

May to July Combined Wind Speed Distributions
St. Anthony Stations
Percent Occurrence
#8403400 (28700 Obs)
#8403401 (22340 Obs)
#8403402 (19350 Obs)
40
35
30
25
20
15
10
5
0
Knots 0 5 10 15 20 25 30 35 40 45 50 55 60
Kph 0 18.5 37.4 55.6 74.1 92.6 111.1
WIND SPEED
1 kt = 1.852 kph


May to July Combined Wind Direction Distributions
St. Anthony Stations
Percent Occurrence
#8403400 (28700 Obs)
#8403401 (22340 Obs)
#8403402 (19358 Obs)
40
35
30
25
20
15
10
5
0
N NE E SE S SW W NW CALM
Wind Direction

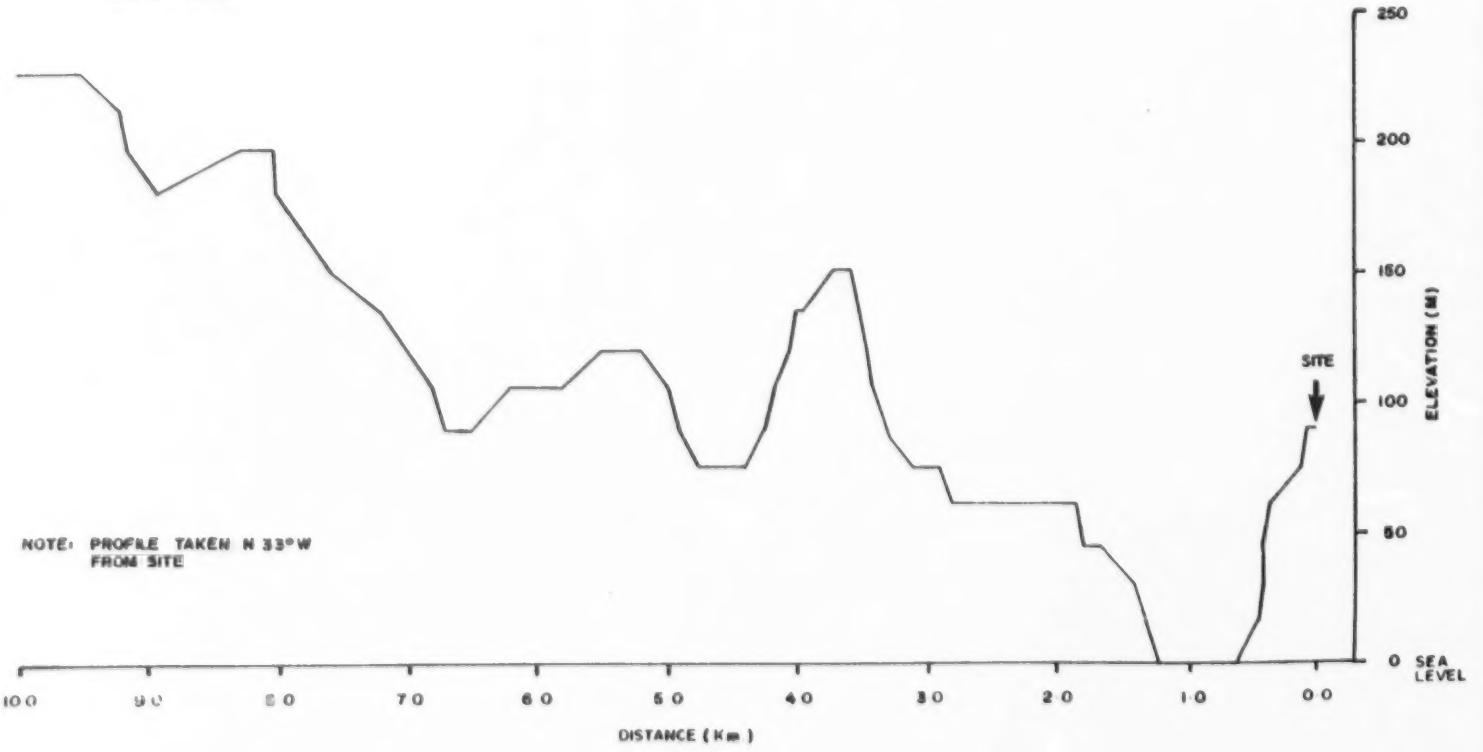
APPENDIX 3

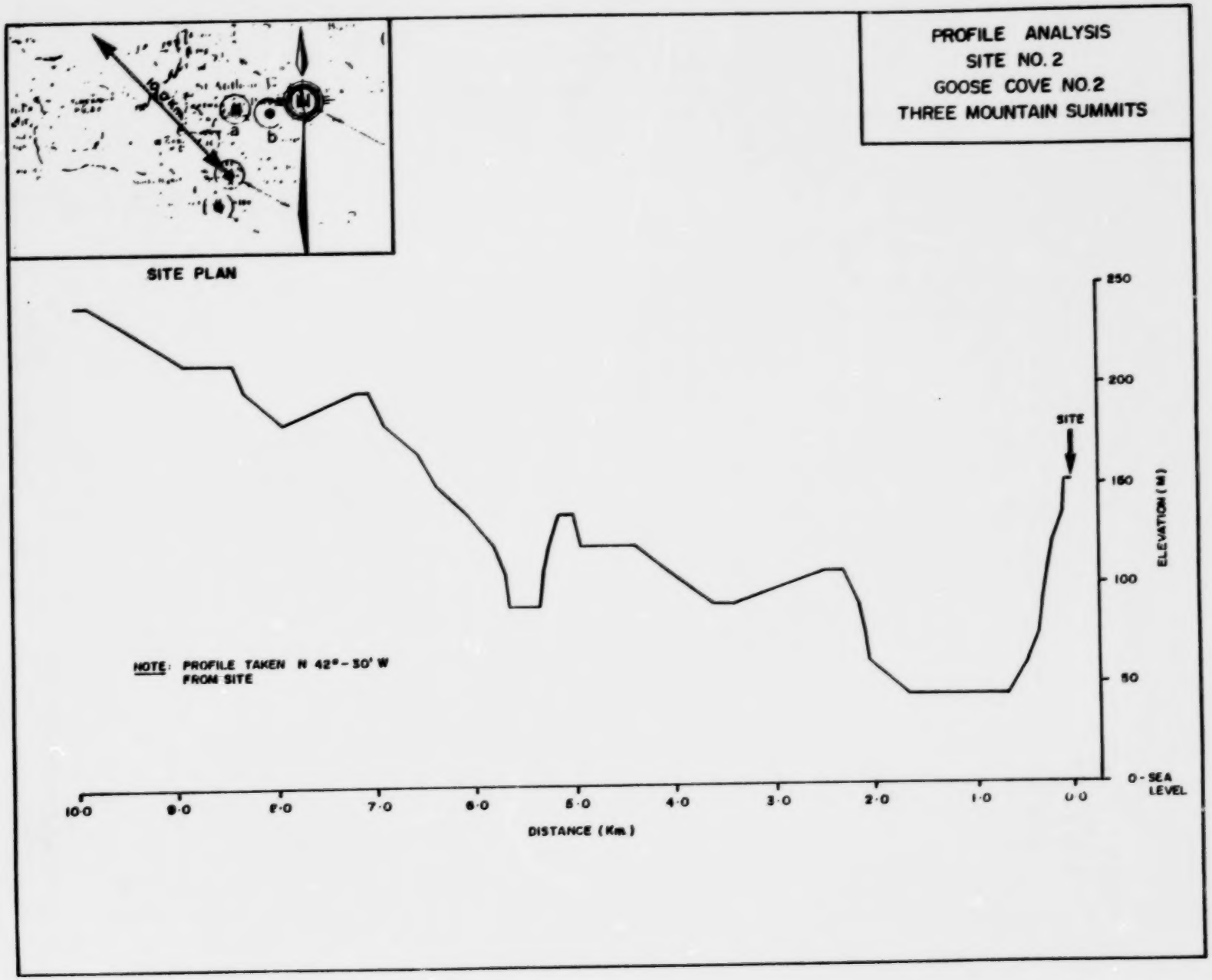
PROFILE DIAGRAMS

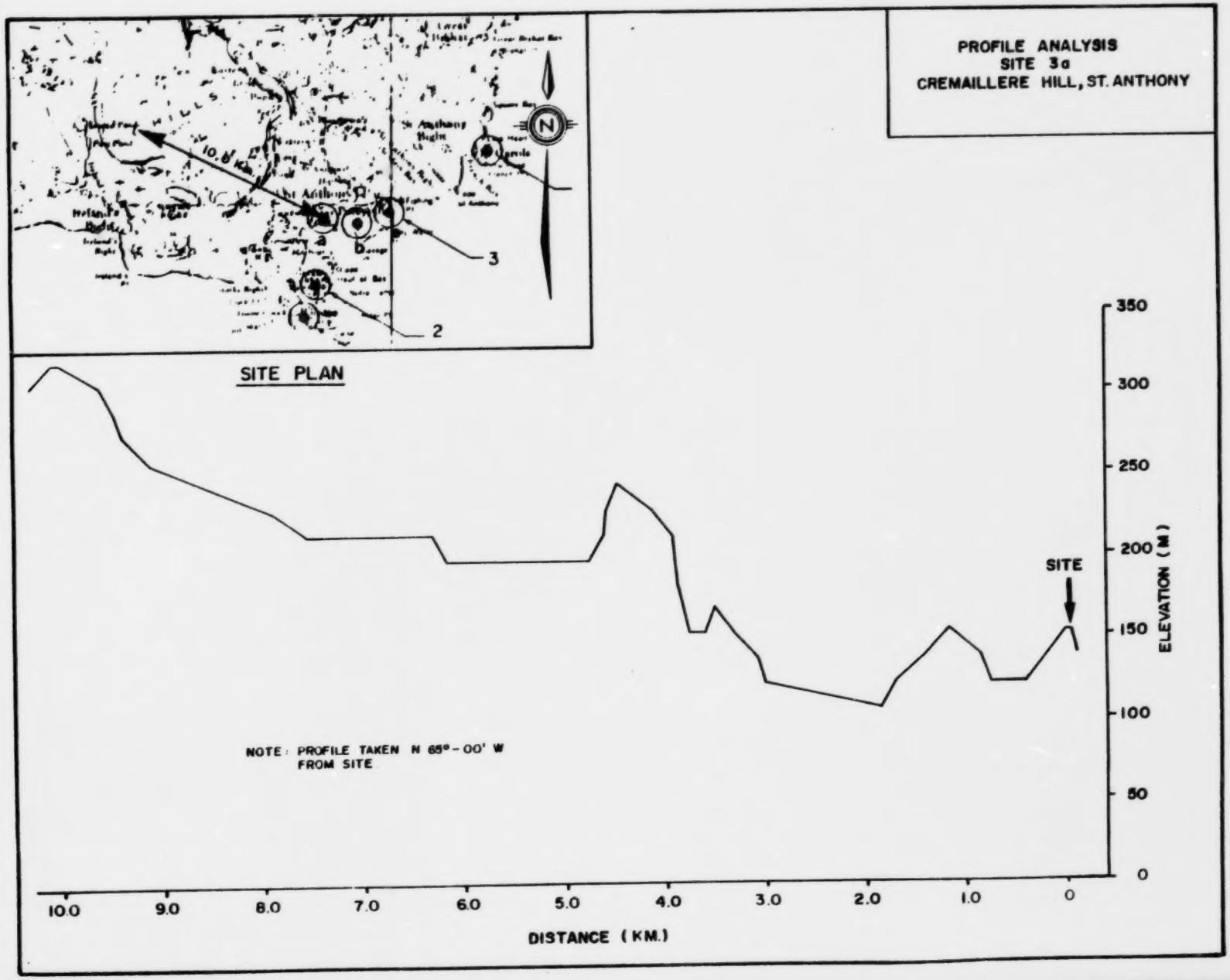
PROFILE ANALYSIS
SITE NO. 1
GOOSE COVE



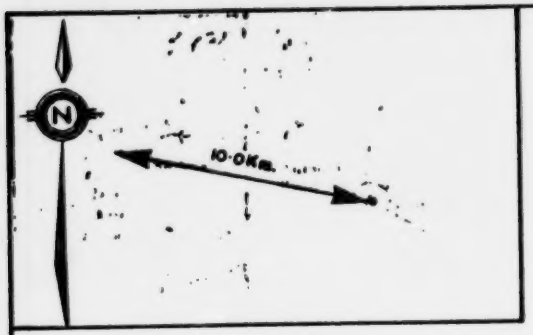
SITE PLAN



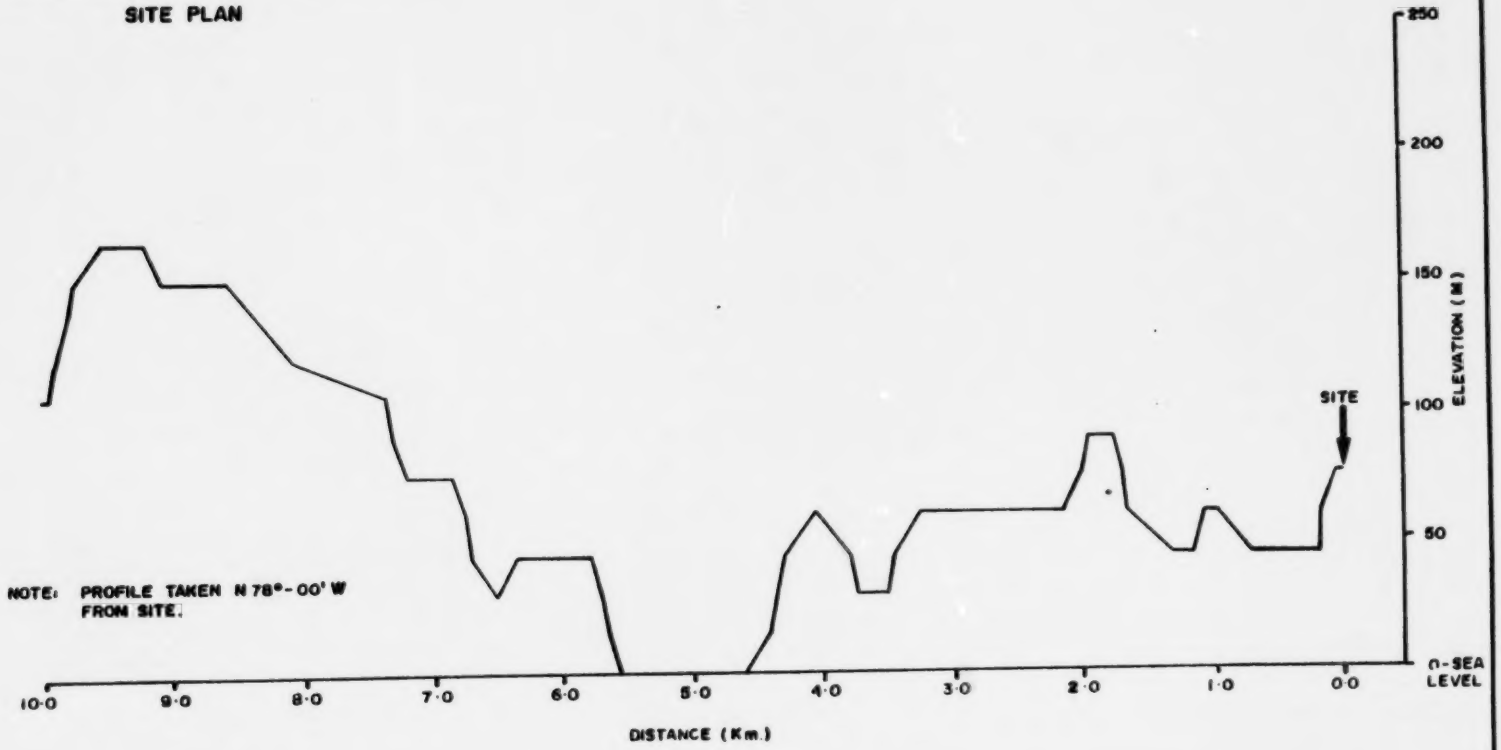

PROFILE ANALYSIS
SITE NO. 2
GOOSE COVE NO.2
THREE MOUNTAIN SUMMITS
SITE PLAN
a
b
SITE
250
200
150
100
50
0 - SEA LEVEL
ELEVATION (M)
NOTE: PROFILE TAKEN N 42°-30' W FROM SITE
10·0
9·0
8·0
7·0
6·0
5·0
4·0
3·0
2·0
1·0
0·0
DISTANCE (Km)


PROFILE ANALYSIS
SITE 3a
CREMAILLERE HILL, ST. ANTHONY
10.8 Km
a
b
3
2
N
SITE PLAN
350
300
250
200
150
100
50
0
ELEVATION (M)
SITE
NOTE: PROFILE TAKEN N 65°-00' W
FROM SITE
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
DISTANCE (KM.)

PROFILE ANALYSIS
SITE NO.4
ST. CAROLS

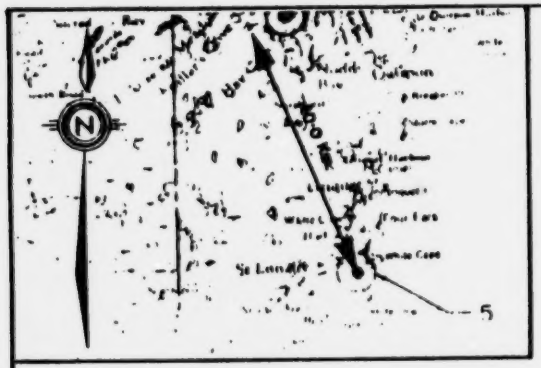


SITE PLAN



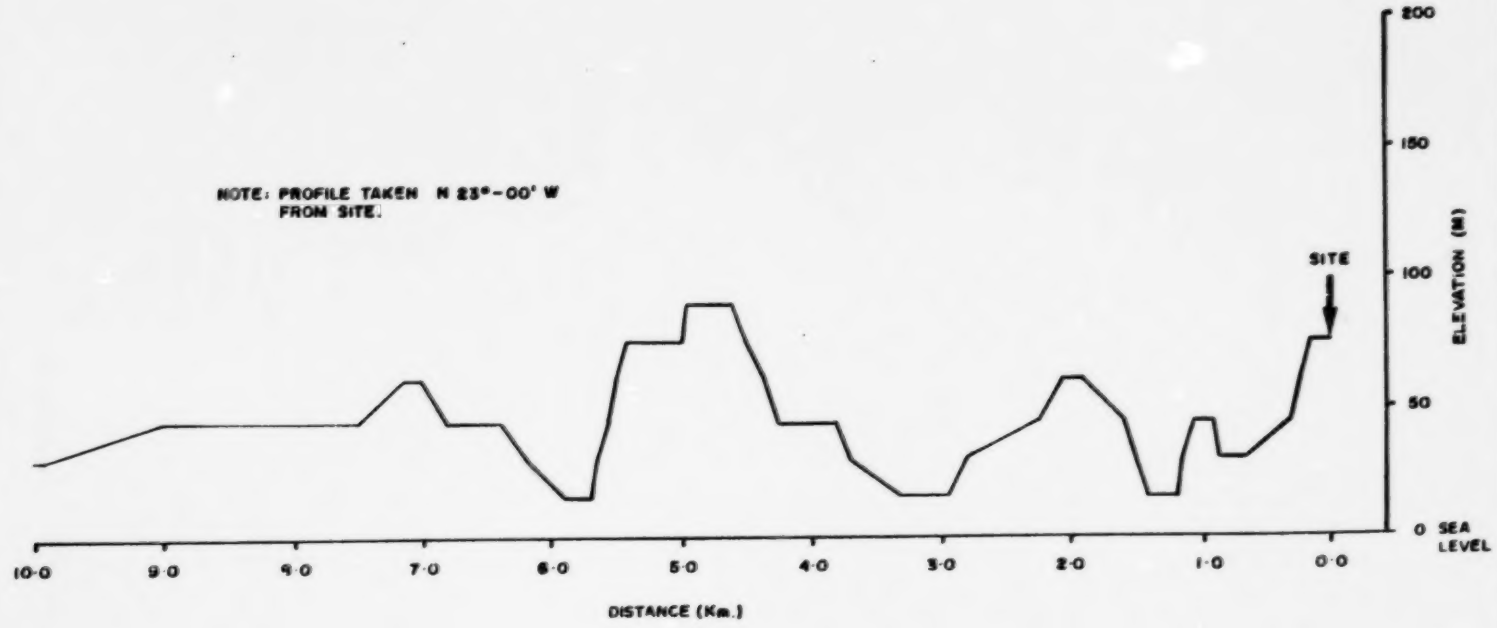
NOTE: PROFILE TAKEN N 78°-00' W FROM SITE.

PROFILE ANALYSIS
SITE NO.5
WHITE CAPE

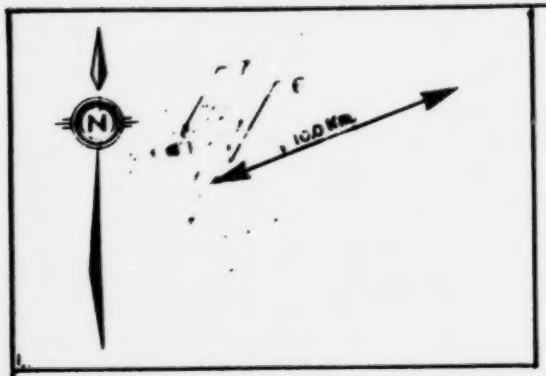


SITE PLAN

NOTE: PROFILE TAKEN N 23°-00' W FROM SITE.

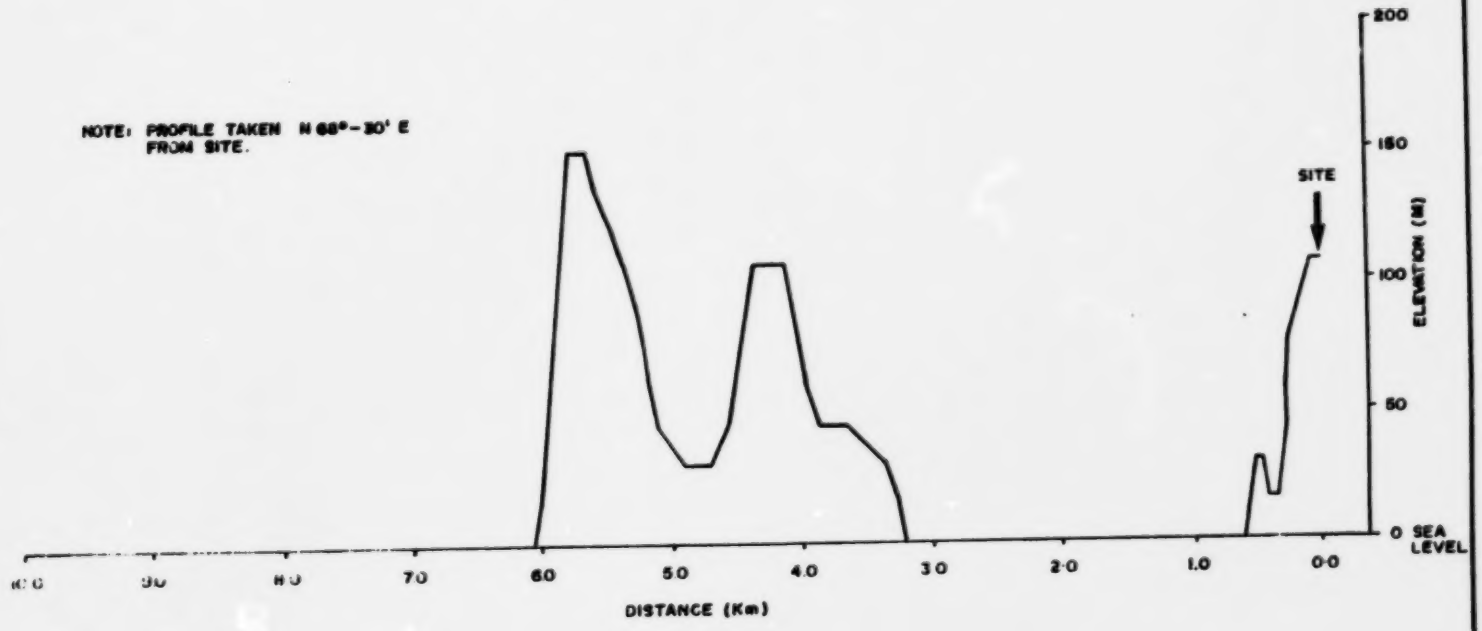


PROFILE ANALYSIS
SITE NO. 6
CAPE RAVEN

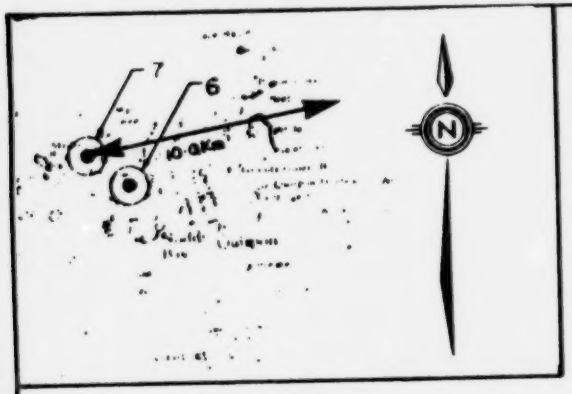


SITE PLAN

NOTE: PROFILE TAKEN N 68°-30' E FROM SITE.

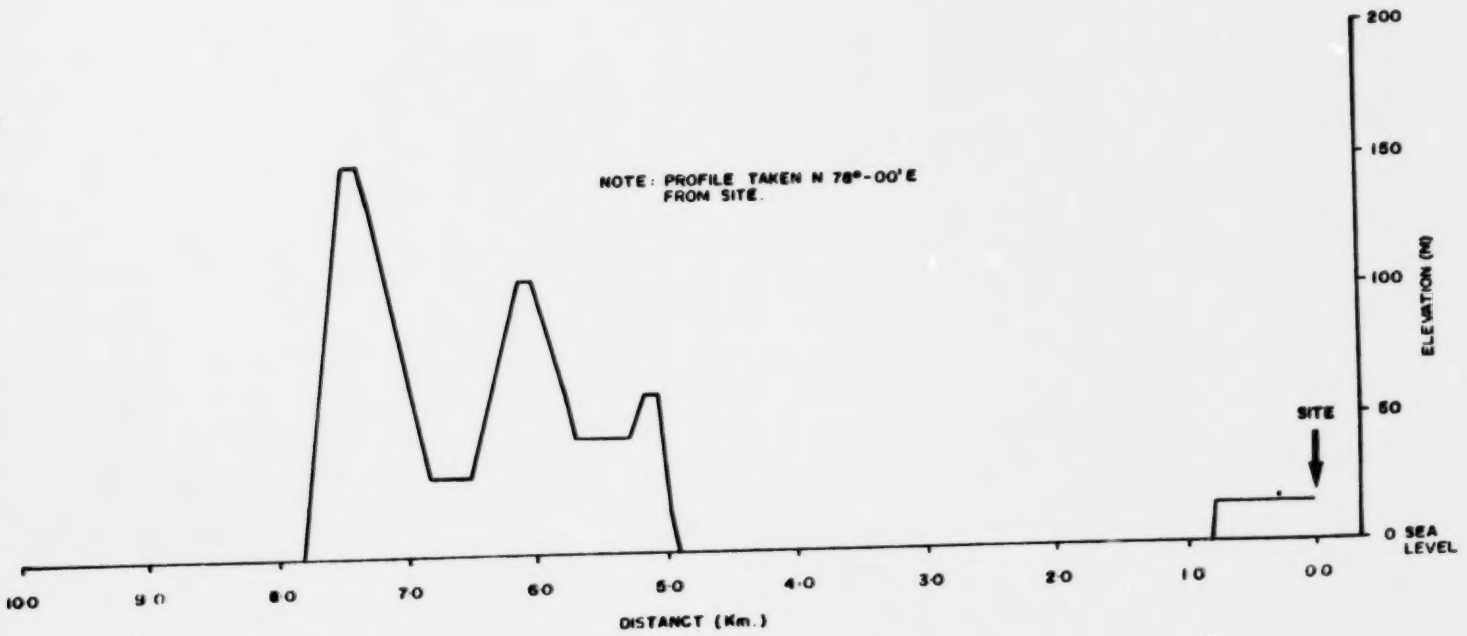


- 96 -

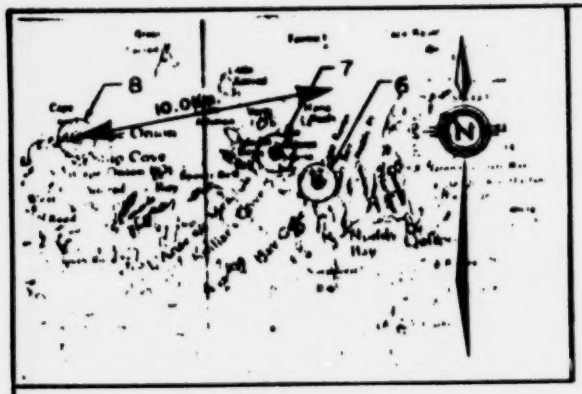


SITE PLAN

PROFILE ANALYSIS
SITE NO.7
L'ANSE AUX MEADOWS

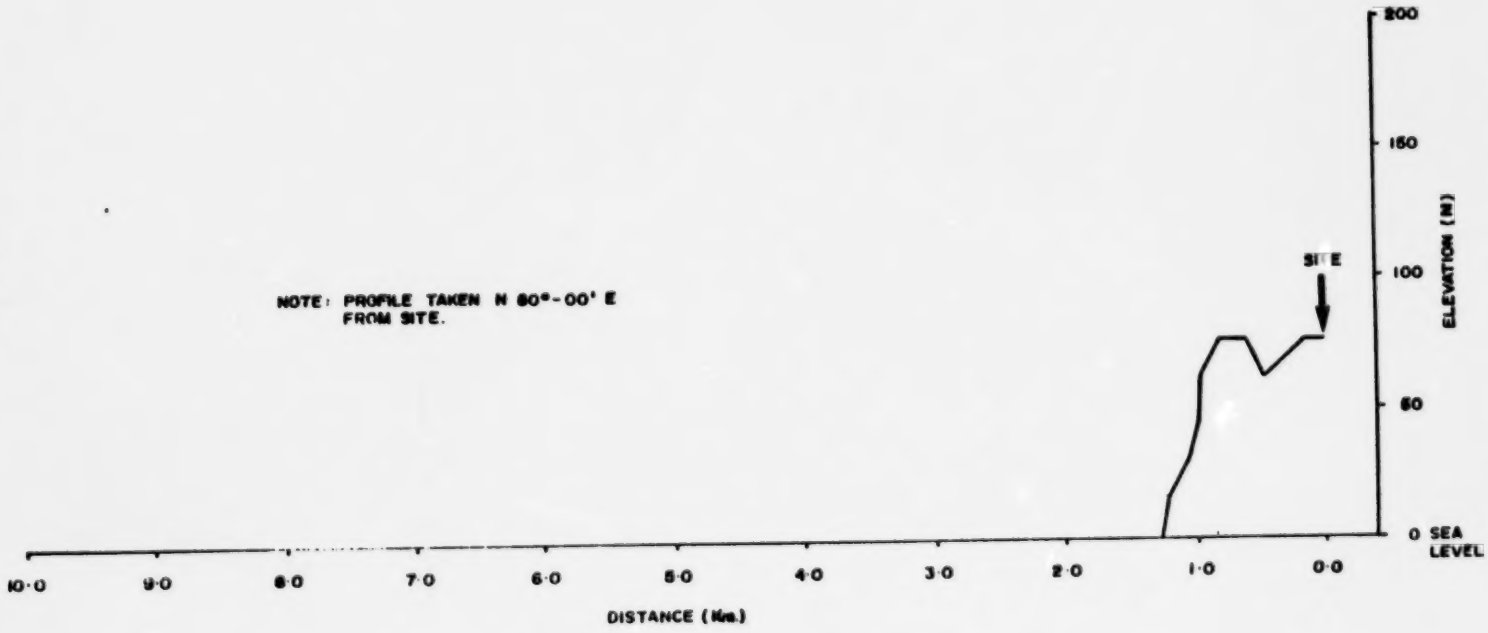


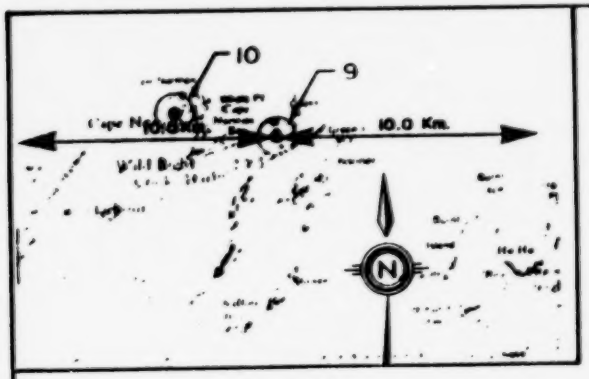
PROFILE ANALYSIS
SITE NO. 8
SHIP COVE



SITE PLAN

NOTE: PROFILE TAKEN N 80°-00' E FROM SITE.

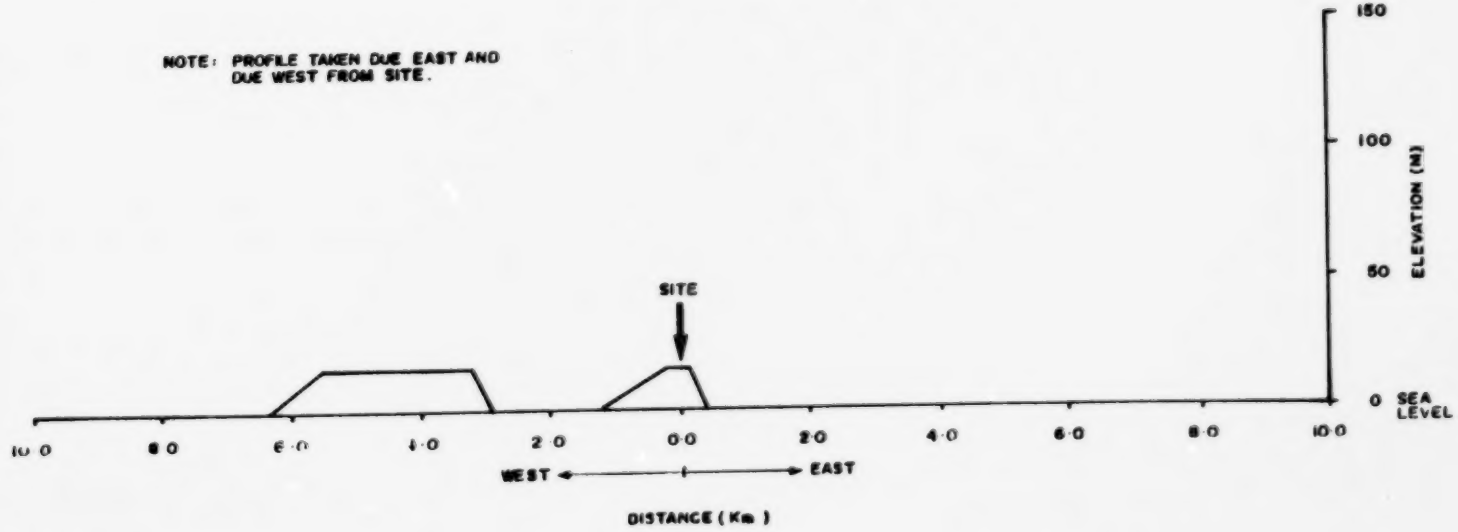




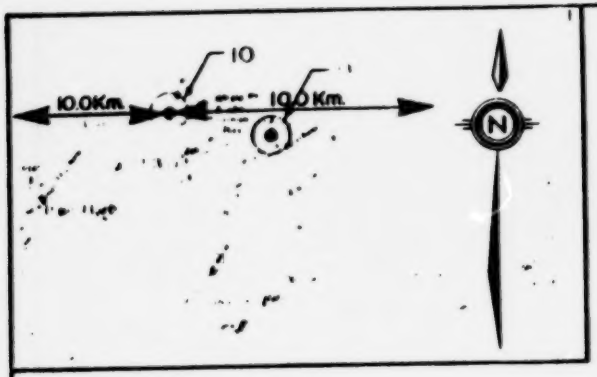
SITE PLAN

PROFILE ANALYSIS
SITE NO. 9
COOKS HARBOUR

NOTE: PROFILE TAKEN DUE EAST AND DUE WEST FROM SITE.

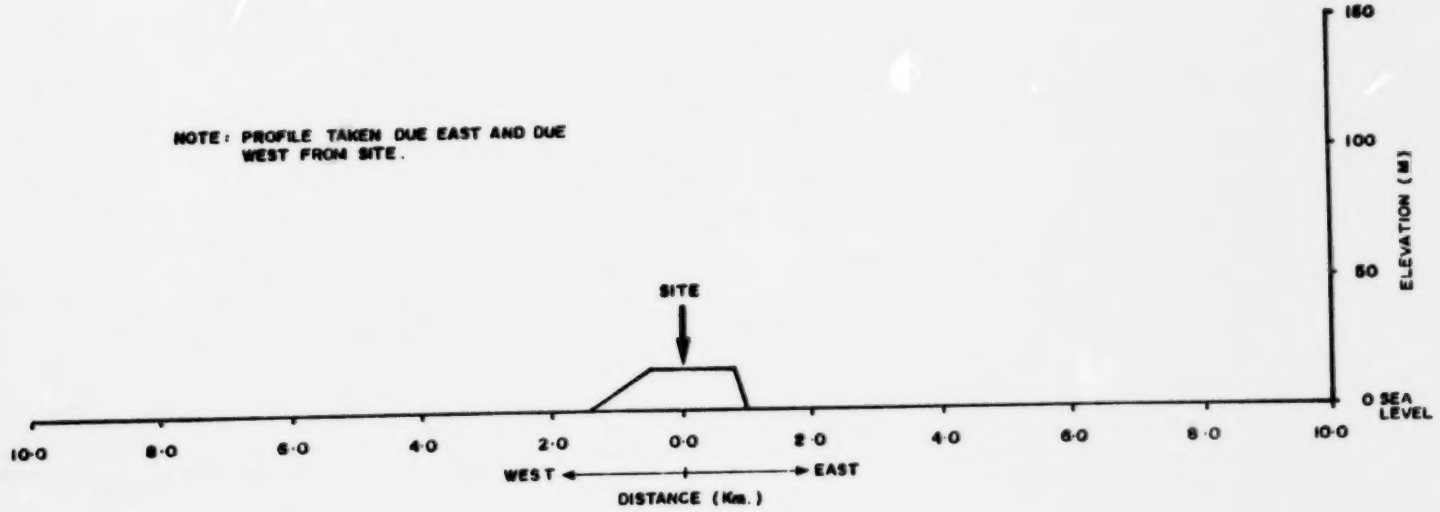


PROFILE ANALYSIS
SITE NO. 10
CAPE NORMAN



SITE PLAN

NOTE: PROFILE TAKEN DUE EAST AND DUE WEST FROM SITE.



APPENDIX 4

CORRESPONDENCE WITH THE DEPARTMENT OF FOREST RESOURCES AND LANDS

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

DEPARTMENT OF FOREST RESOURCES AND LANDS

DEPT. OF FOREST RESOURCES & LANDS
SHOPRITE BUILDING, BROADWAY
BOX 2006, CORNER BROOK, NFLD.
A2H6J8

IN REPLY PLEASE QUOTE FILE NO. .....

85 03 28

FILE #-38099

RECEIVED
APR - 3 1985
FENCO

Fenco Newfoundland Ltd.
P.O. Box 8246
St. John's, NF
A1B 3N4

Att: Bill Melendy

Subject: Sites for Energy Conservation System in St. Anthony to Cape Norman area.

Dear Mr. Melendy:

This is further to our telephone conversation of March 21. Our technician has seen the plan and informed me that all sites with the possible exception of #3 are Crown Land without any hinderances that we know of. Site #3 could be on the former American base.

If we have any questions or comments about the above, please contact this office.

Yours truly,

STANLEY H. HALL
Lands Officer
SHH/apv

APPENDIX 5

CORRESPONDENCE WITH CANADIAN COAST GUARD

Fenco Newfoundland

FENCO NEWFOUNDLAND LIMITED
167 KENMOUNT ROAD - C.O.N. BUILDING
P.O. BOX 4246, ST. JOHN'S, NEWFOUNDLAND, CANADA A1E 3N4
TELEPHONE (709) 754-7450 • TELEX 016 4936 • CABLE: FENCOENG

March 7, 1985

Canadian Coast Guard
P.O. Box 1300
St. John's, Newfoundland
A1C 6H8

Attention: Mr. Burt Hynes, RMTE

Dear Sir,

ST. ANTHONY WIND STUDY

Fenco Newfoundland Limited is undertaking a study for the Department of Energy, Mines and Resources, to identify potential sites for a Wind Energy Conversion System in the St. Anthony area.

Possible interference from such a system must be investigated in order to determine if a potential site will affect existing communication systems.

Thomas Muy suggested I write you for information regarding Coast Guard communication receivers and transmitters in the area. A map or drawing showing the location of all towers in a forty kilometer radius of St. Anthony would be greatly appreciated.

If you have any further comments or concerns regarding this study, please feel free to call.

Yours very truly,
Fenco Newfoundland Limited

Marc Brophy

Marc Brophy

MB/jms
38099

Canadian Coast Guard / Garde côtière canadienne
P.O. Box 1300
St. John's, Nfld.
A1C 6H8

8050-110 (ENG)

March 14, 1985

RECEIVED
MAR 15 1985
FENCO

Fenco Newfoundland Limited
187 Kenmount Road, I.C.O.N. Building
P.O. Box 8246
St. John's, Newfoundland
A1B 3N4

ATTENTION: MR. MARC BROPHY

Dear Mr. Brophy:

SUBJECT: ST. ANTHONY WIND STUDY

As requested in your letter of March 7, 1985, attached please find two (2) topographical maps showing the location of all towers in a forty kilometer radius of St. Anthony.

If you need further information, please feel free to contact Mr. Tomas Muy at 772-4081.

Yours truly,

H. Hynes
Regional Manager
Telecommunications and
Electronics

attach:

Canada